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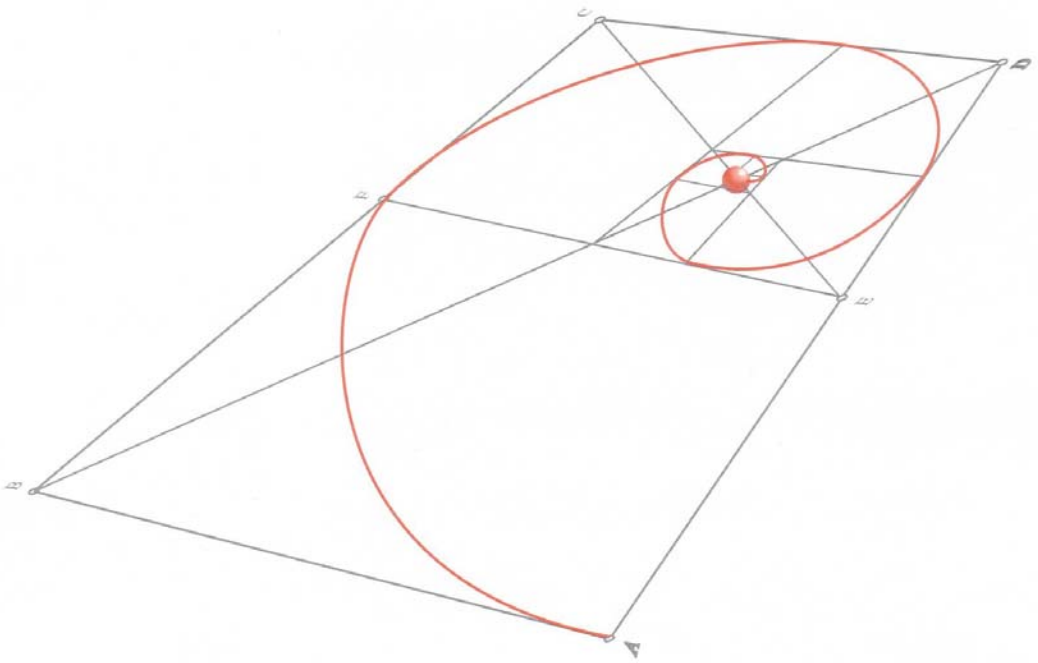

FINAL

Cedar Lake Engineering Feasibility Study

May 24, 2004

Prepared For:
Cedar Lake Enhancement Association
P.O. Box 823
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CEDAR LAKE ENGINEERING FEASIBILITY STUDY

Prepared for

Cedar Lake Enhancement Association, Inc.
Cedar Lake, Indiana

Prepared by:

Environmental Forensics Investigations, Inc.
Chicago, Illinois

In Association With
Baetis Environmental Services, Inc.
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Under the Sponsorship of
Indiana Department of Natural Resources
Lake and River Enhancement Program

May 2004

CEDAR LAKE ENGINEERING FEASIBILITY STUDY

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ACRONYMS AND DEFINITIONS

Baetis	Baetis Environmental Services, Inc.
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
CDS	Continuous Deflective Separation
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CLEA	Cedar Lake Enhancement Association, Inc.
CN	Curve Number
EnviroForensics	Environmental Forensic Investigations
FQI	Floristic Quality Index
FIS	Flood Insurance Study
IAC	Indiana Administrative Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IP	Individual Permits
ISWS	Illinois State Water Survey
LARE	Lake and River Enhancement Program, IDNR
mg/L	Milligrams per Liter
MSL	Mean Sea Level
NRCS	Natural Resources Conservation Service
NPS	Nonpoint Source
NWP	Nationwide Permit
P	Phosphorus
Q_p	Peak Flow
RAS	River Analysis System
ROW	Right-of-way
SCS	Soil Conservation Service
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WQC	Water Quality Certification

1.0 EXECUTIVE SUMMARY

1.1 Background

Cedar Lake is a valuable resource for the Town of Cedar Lake and Lake County, Indiana. Cedar Lake, has historically, and continues to, offer a wealth of water sport activities for seasonal and yearly residents. Cultural eutrophication has affected the recreational uses of the lake for decades. The most obvious symptoms of eutrophication are summer algae mats, sediment plumes seen in the lake following storm events, the large accumulation of sediment in the lake, and reduction in water clarity.

Environmental researchers have studied the eutrophication of Cedar Lake for more than twenty years. This feasibility study is the latest of these investigations. It is an engineering feasibility study for control of non-point source pollutants originating from five small inlets to the lake:

1. North Point Marina
2. Condos
3. Chamber of Commerce
4. Old Bank Building
5. South Shore Country Club

These pollutant controls are aimed at improving water quality in Cedar Lake. Past efforts and improvements have concentrated on some of the larger sources of runoff into Cedar Lake. This report evaluates five of the smaller watersheds.

1.2 North Point Marina Inlet

For this inlet, we investigated grass swales and/or roadside vegetative filters to stabilize roadsides and ditches. We also evaluated detention-based Best Management Practices (BMPs).

1.3 Condos Inlet

For this inlet, we investigated grass swales, roadside vegetative filters, and culvert outlet protection. We also evaluated detention-based BMPs and ways to solve failing streambanks at the mouth of this inlet.

1.4 Chamber of Commerce Inlet

For this inlet, we investigated grass swales and vegetative filters for roadsides and parking areas. We also investigated potential enhancements to a natural wetland along with public education for nuisance wildlife.

1.5 Old Bank Building Inlet

For this inlet, we investigated check dams and/or stabilization of banks in the inlet stream. We also investigated grass swales and vegetative filters for roadsides and parking areas along with detention-based BMPs.

1.6 South Shore Country Club Inlet

For this inlet, we spoke with golf course management about new vegetative management techniques along with vegetative or structural bank protection.

1.7 Recommendations

Based on the results of this study, we recommend the following:

- Detention BMPs, as constructed wetlands are recommended for the North Point Marina and Old Bank Building inlets at the locations detailed in this study. These systems will provide for removal of sediment and associated pollutants from upstream areas. Wetland treatment systems in these areas will also provide some minimal wildlife habitat and aesthetic values. The combined design/construction cost of these two measures is about $94,000 and will constitute measurable reductions in non-point source pollution from these two watersheds.
- A number of watershed BMPs has been determined feasible throughout the watershed. These should be implemented as funds allows.
- The streambank at the Condos inlet should be addressed before further failure. The least costly option is extending the storm sewer pipe to Cedar Lake. However, this option provides no water quality benefits and it may cause surface drainage problems. A better but more costly option is streambank stabilization, or streambank stabilization in conjunction with a sediment trap structure. Inlet sediment control, using a Continuous Deflective Separation (CDS) unit along with streambank stabilization is proposed.
- The streambanks at the Golf Course inlet can be addressed relatively easily through

vegetative and rip-rap designs. However, either of these options is relatively expensive as the slopes are steep and have to be flattened in order for either of these techniques to be effective. At this time, the owners of South Shore Country Club distinctly prefer riprap as they have invested in this solution to stabilize a large portion of the eroding bank.

- Native vegetation planting in the natural wetland in the Chamber of Commerce inlet.

To finance these recommended projects, the most promising funding sources are the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) program, the Build Indiana Fund, and the Indiana Department of Environmental Management (IDEM) 319 fund. We recommend that the Cedar Lake Enhancement Association (CLEA) apply to each of these sources for funding design, construction, and implementation assistance.

2.0 INTRODUCTION

2.1 Background

In 2002, the CLEA was provided a grant under the IDNRs' "T by 2000" LARE program. The grant funds were used to procure the services of a consulting engineering firm to perform a lake enhancement engineering feasibility study.

2.2 Objectives

The lakeside residents and users of Cedar Lake have long expressed concern about deteriorating water quality. In 1978 the Indiana State Legislature appropriated funds to determine the feasibility of restoring Cedar Lake; this study was performed by Echelberger, *et. al.*, 1979. Since 1978, a series of five reports have addressed water quality concerns and possible solutions at Cedar Lake. Some have been implemented. The most significant water quality restoration measure has been the installation of a sewage collection system that the town installed a number of years back. Smaller projects have also been built. In 2001, reaches of eroding lakeshore were stabilized using Build Indiana funding. In 2002, a number of improvements, including streambank stabilization and a constructed wetland, were performed in the Sleepy Hollow Ditch watershed. Additional streambank stabilization is currently being designed and permitted and will be installed in the fall of 2004. These improvements addressed sediment and nutrients from a large portion of the Cedar Lake watershed. Additionally, the CLEA is working with the Corp of Engineers in a Dredging Feasibility Study. This is also expected to be completed in the fall of 2004. The objectives of the current study are to identify lake enhancement projects, to determine feasibility of anticipated construction projects, and to prepare for physical design. This work is being performed for five smaller inlets that discharge into Cedar Lake. They include:

- North Point Marina inlet
- Condos inlet
- Chamber of Commerce inlet
- Old Bank Building inlet
- South Shore Country Club inlet

2.3 Scope of the Study

The feasibility study involved 19 tasks:

1. Update Outdated Parameters and Address Information Gaps
2. Project Progress Reporting
3. Identification of Potential Construction Sites
4. Complete Preliminary Engineering/Calculations
5. Facilitate Public Meetings Regarding the Proposed Project
6. Create a Public Information Handout

7. Determine Unusual Physical and/or Social Costs of the Proposed Project
8. Complete a Flood Stage Analysis if Determined Necessary
9. Determine Easements and Land Availability
10. Determine Functionality and/or Impact of Proposed Project with Respect to Condition of the Lake
11. Conduct a Wetland Functional Assessment or Vegetation Survey
12. Conduct a Survey of Biological and Habitat Integrity Downstream of Proposed Sites
13. Determine Funding Sources for Design and Construction Projects Including Ability of Local Entity to Fund Additional Project Phases
14. Conduct an Environmental Impact Assessment of Pre- and Post Project Conditions with Special Attention to Wetlands, Water Quality and Flooding
15. Document Justification for Proposed Site Selection
16. Complete Early Coordination Process for Obtaining all Project Permits Including USACE, IDEM, USFWS, IDNR, County Drainage Boards, and Pertinent Citizen Organizations
17. Complete Conceptual Drawings
18. Determine Preliminary Design and Construction Project Cost Estimates and Timelines
19. Complete Engineering Feasibility Report

2.4 Acknowledgments

Environmental Forensics Investigations, Inc. (EnviroForensics) and Baetis Environmental Services, Inc. (Baetis) would like to extend appreciation for the assistance given to the study team by the CLEA. Particularly valuable was the assistance and enthusiasm of the CLEA's Board and its President, Mr. Robert Gross, Jr. Also, the assistance of the Town of Cedar Lake is greatly appreciated.

Several individuals and agencies provided important and invaluable data and input for this study: the IDNR Division of Soil Conservation, particularly the LARE Office, and the Divisions of Fish and Wildlife, and Water; the IDEM; the Lake County Soil and Water Conservation District, the USDA Natural Resource Conservation Service; the Environmental Systems Application Center at the School of Public and Environmental Affairs at Indiana University; and the Hanover and Center Township Assessor's Offices.

Mr. Douglas Mulvey and Mr. David Pott of EnviroForensics and Baetis, respectively, wrote this report. The report was reviewed by Krishna Mayenkar of EnviroForensics. The IDNR Division of Soil Conservation administers the LARE Program.

3.0 DESCRIPTION OF THE STUDY AREA

3.1 Location

Cedar Lake is located in the west central section of Lake County in northwestern Indiana. Cedar Lake is located approximately 35 miles southwest of Chicago and is approximately 1.5 miles east of U.S. 41.

3.2 Lake Physical Characteristics

Much of the available information on Cedar Lake has been gathered and published by other authors. Principal sources of information include Echelberger, Jr., *et al.* (1979, 1984), Jones and Marnatti (1991) and Harza Engineering Company (1999, 2001).

Cedar Lake is a 781-acre kettle lake with a maximum depth of 16 feet and a mean depth of 8.8 feet (Jones and Marnatti, 1991). Table 3-1 presents a summary of lake area according to depth.

Table 3-1

CEDAR LAKE DEPTH-AREA RELATIONSHIP

Depth Interval (feet)	Lake Surface Area (Acres)	Lake Surface Area (%)
0-5	177	23
5-10	309	40
10-16	290	37
16+	5	0
Total	**781**	**100**

A dam and gaging station is located at the outlet of the lake, Cedar Creek. The structure maintains a lake level of about 693 feet mean sea level (MSL), providing for a mean storage volume of approximately 6,875 acre-feet. The mean hydraulic retention time is 1.25 years. This lengthy hydraulic retention time has limnological significance for this lake enhancement effort:

- The lake has a high sediment trapping efficiency
- And a high phosphorus settling rate.
- Recovery time will also be lengthy.

The Cedar Lake shoreline is heavily developed with seasonal and year-round residences. The north and south ends of the lake have adjacent wetlands ranging in size up to 400 acres. Boating, fishing, water skiing, duck hunting, and swimming are popular activities on the lake (Jones and Marnatti, 1991).

3.3 Watershed Characteristics

Figure 1 shows a map of the overall Cedar Lake watershed. The Cedar Lake watershed is part of the 3,000 square mile Kankakee USGS Cataloging Unit 07120001. The total watershed area inclusive of the lake is approximately 5,403 acres. The surrounding watershed drains to Cedar Lake primarily through three inlets from the south and southwest sides. Two of the inlets (Pickerel Creek and an unnamed outlet near Pine Crest Marina) drain Cedar Lake Marsh, a 400-acre wetland to the south of Cedar Lake. Cedar Lake Marsh in turn drains approximately one-half of the total watershed area. The third inlet is Sleepy Hollow Ditch on the southwest side of the lake. Sleepy Hollow Ditch drains an area of approximately 1,250 acres or approximately one-quarter of Cedar Lake's watershed. Land use in the overall Cedar Lake watershed is shown in Table 3-1.

Table 3-1

LAND USE IN THE CEDAR LAKE WATERSHED
(Source: Indiana GAP Database)

Land Use	Area (Acres)	Area (%)
Urban	674	12.5
Agriculture	2,654	49.1
Forested	825	15.2
Wetland	376	7.0
Water (including Cedar Lake)	874	16.2
Total	**5,403**	

The five smaller inlets and watersheds that were studied as part of this project are also shown in Figure 1. Land use in the five subwatersheds of interest is shown in Table 3-2.

Table 3-2

LAND USE IN SELECT CEDAR LAKE SUBWATERSHEDS
(Source: Indiana GAP Database)

Land Use	Chamber of Commerce		Old Bank Bldg.		Golf Course		North Point Marina		Condos	
	(acres)	(%)	(acres)	(%)	(acres)	(%)	(acres)	(%)	(acres)	(%)
Urban	52	32	18	11	10	14	43	13	18	10
Agriculture	7	5	82	50	38	55	81	24.5	48	26
Forested	88	54	63	39	21	31	161	48	116	64
Wetland	12	7					19	6		
Water	4	2					28	8.5		
Total	**163**	**100**	**163**	**100**	**69**	**100**	**332**	**100**	**182**	**100**

Hydrologic data for this study came from the National Weather Service (NWS), United States Geological Survey (USGS), and the Illinois State Water Survey (ISWS). There is a USGS maintained stream gage on Cedar Creek just downstream of the dam on Cedar Lake. Precipitation data was compiled from the weather station at the Valparaiso, Indiana Waterworks Building for the period 1920-1996. Based upon these seventy-six years of data, a mean yearly rainfall of 38.37 inches (with a standard deviation of 6.56 inches, a maximum of 57.77 inches, and a minimum of 24.05 inches) was calculated.

National Wetlands Inventory maps for Lowell and St. John, Indiana were obtained from the US Fish and Wildlife Service. In general, the majority of areas defined as wetlands are located on the north, south and east sides of the lake.

3.4 Soils

The soils in the Cedar Lake watershed are generally of the Morley-Blount-Pewano and Elliott-Markham-Pewamo associations. A more site-specific discussion of soils is provided in Section 5.7.

3.5 Water and Sediment Quality

Cedar Lake has historically experienced degraded water quality. Effluent from improperly installed and/or maintained on-site septic systems contributed significant quantities of nutrients, bacteria and biochemical oxygen demand (BOD) to Cedar Lake up to the mid-1970s when construction of a wastewater collection system was completed and shoreline residents began hooking up to the system (Jones and Marnatti, 1991). With development of the sewage collection and treatment system, lake water quality began to improve, but still remains poor.

This is result of agriculture and urban runoff entering the lake through a few streams and a number of storm sewer inlets. The 2002 Indiana Fish Consumption Advisory (http://fn.cfs.purdue.edu/anglingindiana/Advisories02/LakeCounty.PDF) lists a moderate Fish Consumption Advisory for PCBs for catfish thirteen inches and greater caught in Cedar Lake.

Table 3-3 presents the most recent Indiana Volunteer Lake Monitoring Program data for the lake. These data indicate gradually improving water transparency and lower phosphorus concentrations.

Table 3-3

VOLUNTEER LAKE MONITORING DATA (1996-2002)
(Source: SPEA, Indiana University)

Year	Mean Total P (µg/L)	Mean Secchi Depth (feet)	Mean Chlorophyll *a* (µg/L)
1996	167	1.0	38
1997	225	0.9	127
1998	159	1.3	65
1999	216	1.2	46
2000	139	1.3	46
2001	101	1.7	4
2002	94	1.4	78

Despite these demonstrated improvements, Cedar Lake continues to have high concentrations of nutrients and poor water clarity. For comparison to the above Volunteer Monitoring Program data, the United States Environmental Protection Agency (USEPA) National Eutrophication Survey (USEPA, 1974) considered total phosphorus concentrations above 20 µg/L to be representative of eutrophic lakes. Therefore, Cedar Lake has high phosphorus concentrations, and would be considered by most limnologists to be eutrophic, or even hypereutrophic.

Harza Engineering Company (Harza) collected and analyzed twenty-two sediment samples and water quality parameters in July 1998 (Harza, 1999). Results from these analyses suggest that the lake sediments are highly contaminated with phosphorus. Samples also contain relatively high percentages of organic matter, which may reflect the lake's eutrophy and high level of autochthonous productivity. Six nearshore sediment samples were also collected in July 1998 for *Escherichia coli* analysis. *Escherichia coli* results suggest that the inlet on the north end of the lake (Chamber of Commerce inlet), which drains a small watershed, poses some concern to swimmers.

In a subsequent diagnostic study, Harza collected three sets of wet weather water quality samples from some or all of the five inlets that are part of this engineering feasibility study. Tables 3-4 through 3-6 provide these data. *Escherichia coli* in samples from the Chamber of Commerce inlet were below the water quality standard. These data were used in the diagnostic study to aid estimation of pollutant loads from each of the five inlets (Table 3-7).

Table 3-4

FEBRUARY 2000 WATER QUALITY RESULTS
(Source: Harza 2001)

Description	Chamber of Commerce	Old Bank Bldg	Golf Course
Date	28-Feb-00	28-Feb-00	28-Feb-00
E. coli (/100 mL)	3	150	<3
BOD-5 day (mg/L)	<4	<4	<4
Ammonia N (mg/L)	<0.5	<0.5	<0.5
Nitrate N (mg/L)	1.8	1.7	1.0
ortho Phosphorus (mg/L)	0.12	0.04	0.04
Total Phosphorus (mg/L)	0.19	0.04	0.05
Total Suspended Solids (mg/L)	<5	58	46

Table 3-5

MARCH 2000 WATER QUALITY RESULTS
(Source: Harza 2001)

Description	Chamber of Commerce	Old Bank Bldg	Golf Course	North Point	Condos
Date	20-Mar-00	20-Mar-00	20-Mar-00	20-Mar-00	20-Mar-00
E. coli (/100 mL)	70	270	130	360	270
BOD-5 day (mg/L)	<4	<4	6	<4	<4
Ammonia N (mg/L)	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate N (mg/L)	<1.0	1.5	<1.0	2.7	1.5
ortho Phosphorus (mg/L)	<0.06	0.012	0.22	0.31	0.13
Total Phosphorus (mg/L)	0.11	0.18	0.22	0.14	0.09
Total Suspended Solids (mg/L)	12	11	68	18	13

Table 3-6

MAY 2000 WATER QUALITY RESULTS
(Source: Harza 2001)

Description	Chamber of Commerce	Old Bank Bldg	Golf Course	North Point	Condos
Date	12-May-00	12-May-00	12-May-00	12-May-00	12-May-00
E. coli (/100 mL)	93	93	460	<3	93
BOD-5 day (mg/L)	<4	6	20	<4	<4
Ammonia N (mg/L)	2	<0.5	<0.5	<0.5	<0.5
Nitrate N (mg/L)	<1	<1	<1	<1	1.1
ortho Phosphorus (mg/L)	0.07	0.05	0.02	0.07	0.06
Total Phosphorus (mg/L)	0.38	0.18	0.18	0.13	0.1
Total Suspended Solids (mg/L)	78	140	40	99	8
Water Temperature (Centigrade)	19.5	16.5	19.2	19	17.3
Sample Depth (feet)	0.5	0.1	0.5	0.33	0.5
Dissolved Oxygen (mg/L)	1.3	7.4	5.1	8.7	6.5
Specific Conductivity (mS/cm)	1.04	1.15	0.415	1.12	3.19
Turbidity (NTU)	7	10	40	7	7

3.6 Other Resources

The DNR Division of Nature Resources was contacted during this study. They checked the Indiana Natural Heritage Program's database and sent a letter regarding their concerns (Appendix A). In summary, the Division had the following comments:

1. Horned pondweed (*Zannichellia Palustris*) has been identified as a "state endangered" species present in Cedar Lake Marsh

However, in discussions with them, they note that this is a very old record (1930s) and that this species is probably no longer present.

The United States Department of the Interior, Fish and Wildlife Service was also contacted during this study. A letter was sent regarding their concerns. In summary, the Service had the following comments:

1. Cedar Lake is within the range of the federally endangered Indiana bat (*Myotis sodalis*) and the Karner blue butterfly (*Lycaeides melissa samuelis*), and the federally threatened Meads milkweed (*Asclepias meadii*), bald eagle (*Haliaeetus leucocephalus*), and Pitcher's thistle (*Cirsium pitcheri*).
2. Suitable potential habitat for the Indiana bat might be found along Cedar Creek, downstream of Cedar Lake. The tributaries into Cedar Lake may be too small and/or

developed to support Indiana bats; therefore, specific project proposals would need to be reviewed to determine whether or not surveys for this species are required.

3. There is no habitat for the Karner blue butterfly in the Cedar Lake area.
4. There is no specific habitat for bald eagles at Cedar Lake.
5. Pitcher's thistle is not found at Cedar Lake.
6. Mead's milkweed is present 3 miles northwest of Cedar Lake, but that site is not in the lake's watershed.
7. Cedar Lake Marsh is known to provide habitat for a number of Indiana-listed endangered, threatened, rare, or special concern species of flora and fauna.

4.0 LAKE ENHANCEMENT ALTERNATIVES

4.1 Problem Statement

Cedar Lake is a valuable resource for the Town of Cedar Lake and Lake County. Cedar Lake has historically and continues to offer a wealth of water sport activities for seasonal and year round residents. The recreational uses of the lake have been impaired for decades by the cultural eutrophication of the lake. The most obvious symptoms of this eutrophication are summer algae mats, sediment plumes seen in the lake following storm events, the large accumulation of sediment in the lake, and reduction in water clarity. While several projects with positive effects have been implemented from the 1980s through today, Cedar Lake continues to have poor water quality and is significantly below the quality desired by the Town's residents.

Today at Cedar Lake, nonpoint sources, coupled with internal recycling of phosphorus, are the greatest causes of water quality degradation. Since one-half of the Cedar Lake's watershed drains through the 400-acre Cedar Lake Marsh, treatment of this source of potential sediment and nutrients is considered adequate, although confirmation testing should be performed. One-quarter of the lake's watershed drains through Sleepy Hollow Ditch. A constructed wetland/sediment trap and bank stabilization were performed on Sleepy Hollow ditch in 2002. Additional streambank stabilization will occur in 2004. Therefore, approximately 75% of the watershed drains through structures that reduce sediment and nutrient loads to the lake. The U.S. Army Corps of Engineers is currently undertaking a Section 206 (Detailed Project Report) study for ecosystem restoration that includes dredging to control internal recycling of nutrients. Dredging has been estimated to cost approximately $8 million (Harza 1999); while it seeks outside financing for this undertaking, the CLEA wants to continue to address water quality in the community. This study concentrates on the remaining five small subwatersheds.

Nonpoint source control of phosphorus inputs to the lake is generally linked with control of soil erosion and sedimentation through BMPs and/or sediment traps. Phosphorus is generally transported in streams adsorbed to soil particles, so removal of the soil particles from the stream system frequently removes incoming phosphorus as well.

4.2 Approach

An engineering feasibility study identifies, screens, and compares project alternatives and to accomplish a goal, and selects one or more for further study or design. Alternative methods for reducing pollutant loads from five small inlets to Cedar Lake were evaluated using a two-level procedure, with the depth of study increasing as the list of alternatives narrowed to those most feasible. The evaluation involves:

- **Identification and Screening** - A comprehensive list of reasonable pollutant reduction methods for each of the five inlets was compiled. Alternatives, which

were obviously not applicable to Cedar Lake, had unacceptable environmental impacts, or unproven technology were eliminated from further consideration.

Feasibility Evaluation - Alternative methods were evaluated for technical feasibility. The alternatives remaining for evaluation at this level of study were prioritized for implementation based on effectiveness and cost.

4.3 Identification and Screening

For the purposes of lake enhancement, we have focused our study on alternative methods to reduce sediment and phosphorus loadings to Cedar Lake. While there is evidence that other pollutants are impairing lake use (*Escherichia coli* numbers impairing contact recreation, PCBs impairing fish consumption), we have not specifically addressed those sources. Reductions in sediment and phosphorus loadings will have the greatest benefits to lake trophic status and, generally, to overall water quality.

A comprehensive list of a lake enhancement measures was generated for each of the five inlets from compiling the recommendations of past investigators, recent workshops held with lake users, and expertise of the engineer. Appendix B presents a technical memorandum, which identified and screened alternatives for reducing phosphorus and sediment loads to Cedar Lake from each of the five inlets. Alternative projects recommended for more detailed analysis are shown in Table 4-1.

Table 4-1

RECOMMENDATIONS FOR FEASIBILITY STUDY

Inlet	Recommendations for Detailed Investigation
North Point Marina	1. Investigate installation of grass swales and/or roadside vegetative filters to stabilize eroding roadsides and ditches 2. Evaluate benefits related to enhanced ponding upstream of railroad embankment on west side of marina inlet 3. Confirming the sewer hookups for the trailers at the marina
Condos	1. Investigate installation of grass swales, roadside vegetative filters, and culvert outlet protection 2. Evaluate feasibility of detention-based BMP in open channel
Chamber of Commerce	1. Investigate installation of grass swales and vegetative filters for roadsides and parking areas 2. Investigate potential enhancements to promote longer retention in existing wetland 3. Consider public education program for nuisance wildlife
Old Bank Building	1. Investigate check dams and/or stabilization of banks in the downcutting stream 2. Investigate installation of grass swales and vegetative filters for roadsides and parking areas 3. Evaluate installation of a detention-based BMP in the open channel east of Morse Street
Golf Course	1. Interview the golf course owners and managers and investigate their views on new vegetation management techniques to reduce goose use 2. Investigate their willingness to install vegetative or structural bank protection

Most alternatives presented in Table 4-1 discuss prevention and/or containment of eroded soil. These thirteen items have been carried through to the feasibility level for further consideration.

4.4 Feasibility Evaluation

The following sections provide overviews of each of the projects carried through to the feasibility evaluation level.

4.4.1 North Point Marina Inlet Improvement Recommendations

Three items were identified for further investigation for the North Point Marina inlet:

1. Investigate installation of grass swales and/or roadside vegetative filters to stabilize eroding roadsides and ditches
2. Evaluate benefits related to enhanced ponding upstream of railroad embankment on west side of marina inlet
3. Confirming the sewer hookups for the trailers at the marina

Option 1: Grass swales and/or roadside vegetative filters

Grass swales and/or roadside vegetative filters are a BMP to improve water quality by reducing erosion and promoting settlement of suspended particles (Figure 2). They are typically designed to trap solids, promote infiltration, and reduce the flow velocity of runoff. They are applicable to a variety of urban land uses where surface water is discharged as overland sheet flow and they can be used to replace curbs, gutters, and storm sewer systems.

Much of the suspended soils load in the North Point Marina inlet is derived from erosion of disturbed or un-maintained roads, roadsides, and ditches. In general, grass swales and/or roadside vegetative filters are feasible for the majority of the watershed. These improvements could be performed adjacent to existing roads and parking areas. There are instances along Lakeshore Drive where storm drain inlets are located in unpaved and unvegetated areas impacted by traffic (see example photographs in Appendix C, Figures 3 and 4). Sand and gravel directly enter these inlets and are transported to the lake during storm events. Hardening the area surrounding the inlet would reduce solids loadings, as would exclusion of vehicular traffic (through curbing, decorative fencing or other structural measures) and revegetation of the areas around the inlet to filter the stormwater. Decorative pavement, having high porosity, is recommended over traditional asphalt. It is our understanding that the LARE program will likely not fund curbing or decorative fencing. Additionally, these solutions are a low priority for the Town of Cedar Lake. However, the Town and CLEA might be able to work out an arrangement for a pilot scale project using these solutions.

Effectiveness of vegetative filters is dependent on dense, vigorous plant growth and sheet flow across the BMP. Maintaining effective filters can be challenging in a roadside setting with damage from vehicular traffic, winter salt applications and snowplowing, and too much, or too concentrated runoff, which can cause gullies.

Option 2: Detention BMP

Ponds, whether wet or dry, and wetlands are examples of detention-based BMPs. Wetlands, whether natural, incidental, or constructed, are depressed areas that allow sedimentation to take place. Wetlands support aquatic and hydric plants, which aid in sedimentation and nutrient assimilation. Newly-formed constructed wetlands generally have soils capable of adsorbing relatively large amounts of phosphorus.

Wetland morphology is an important determinant of effectiveness. Deeper wetlands have higher hydraulic detention times and hence higher sedimentation rates, but there is less opportunity for nutrient binding with wetlands soils, the primary nutrient removal mechanism. For purposes here, we have assumed that minimal grading and excavation would be required (i.e. the design will mimic the natural topography of the region to the extent feasible). This is beneficial in that it keeps construction costs low and it does not destroy significant vegetation and erosion control

potential already established at the site.

IDEM does not permit the use of natural wetlands for stormwater detention or treatment. We have identified an incidental wetland in the watershed. It is incidental because it was created through the construction of a now-abandoned railroad embankment. Discussions with IDEM and IDNR have concluded that they do not have a problem with an instream wetland developed at this site (Appendix C). The site has natural topography conducive to wetland development (Appendix D, Figure 12); it is currently partially a residential lawn and partially unmaintained shrubs and successional vegetation.

A wetland/sediment trap located at the proposed area could be designed with a weir, approximately 50 feet in length. Figures 3 and 4 provide a proposed location and conceptual design. The weir could be constructed either of steel or plastic sheetpile and be designed to allow minimal impact to normal stream flow. Berms could be used around the wetland as needed to control water levels and size of the wetland. The impact of the designed weir would be most noted during higher flow events where the weir would cause water to pond behind it and gradually be released. During events that the weir fills to capacity, the wetted area behind the weir would approach 1 acre, depending on final design.

Option 3: Sewer hookups

Discussions with local homeowners, the Town and review of sewer maps indicate that the trailers at the marina are hooked to the sewer system. In fact, according to the same sources, all homes around the lake and in the near vicinity are hooked to the sewer system.

4.4.2 Condos Inlet Improvement Recommendations

Two items were identified for further investigation for the Condos inlet:

1. Investigate installation of grass swales, roadside vegetative filters, and culvert outlet protection
2. Evaluate feasibility of detention-based BMP in open channel

Option 1: Grass swales, roadside vegetative filters, and/or culvert outlet protection

As in the North Point Marina drainage, much of the suspended soils load in the Condos inlet is derived from erosion of disturbed or un-maintained roads, roadsides, and ditches. Typical sites such as that pictured in Appendix D Figures 3 and 4 and Appendix B Photo Log page 3 are commonplace. A majority of the sediment plumes can be attributed to the development that is occurring in the new Havenwood subdivision in the upstream reaches of the watershed. Since develop has started, they have strawed and seeded exposed banks which will reduce some of the sediment load. Detention structures for the development will decrease peak runoff from this area. After leaving Havenwood, runoff predominately discharges through urban ditches. There is a

small section of woods which the stream discharges through. Banks are relatively flat in the wooded area; therefore, bank erosion is not very evident until further downstream where the discharge is occurring mainly through the sparsely vegetated urban ditches.

In general, grass swales and/or roadside vegetative filters (Figure 2), perhaps in combination with curbing and gutters (Figure 5) and culvert outlet protection (Figure 6) are feasible. Again, as pointed out earlier, this BMP is dependent on dense, vigorous plant growth and sheet flow, and maintenance can be challenging in a roadside setting.

Option 2: Detention

Detention was explored for this inlet into Cedar Lake. Options were limited because of the tendency of the stream to be discharged through culverts instead of through natural stream channels. Although a few upstream locations exist where a wetland could be sited, the stream channels are heavily wooded in these areas and the area is a forested wetland. In such a setting, we expect permitting complications, and these areas were not considered further.

Appendix D Figure 1 shows the channel between the condos and a single-family residence where it discharges to Cedar Lake. Note the area of streambank that has started failing. This bank has failed since this picture was taken. The 100-foot open channel to the lake is narrow and the banks are very steep, rising as much as 20 feet above the stream. Significant earthwork would be required to create a detention-based BMP here. Disturbance to the banks and stream channel and the adjacent condominium and single-family properties would be create unusual costs and this project was considered unfeasible and removed from further consideration.

An in-lake sediment trap would also considered, but the immediate residents use the area for recreation and such a structure would not be perceived as an amenity benefiting them.

Continuous Deflective Separation (CDS) units are a non-blocking, non-mechanical liquids separating and screening technology. The technology utilizes fluid flows in a balanced system to cause a natural separation of solids. Solids are captured and retained within the central chamber and the fluid passes through the screen and exits via the outlet pipe. The solids can be removed using a vacuum truck. Fine screen insets can be used in storm water applications to collect sediments. The fine screens vary in size from 1,200 to 4,700 microns. The recommended design flows for CDS units are typically those with a return frequency of 3 to 6 months. These flows are normally in excess of those required to generate movement of pollution typically associated with "first flush" events. Figure 7 provides a schematic of a CDS unit.

4.4.3 Chamber of Commerce Inlet Improvement Recommendations

Three items were identified in the Technical Memorandum for further investigation for the Chamber of Commerce inlet:

1. Investigate installation of grass swales and vegetative filters for roadsides and parking areas
2. Investigate potential enhancements to promote longer retention in existing wetland
3. Consider public education program for nuisance wildlife

Option 1: Grass swales and/or roadside vegetative filters

As with Cedar Lake's other urbanized drainages, the roadsides and parking areas in this drainage contribute much of the suspended soils load. Vegetating these areas, perhaps in combination with traditional or novel curbing and guttering, should reduce the erosion.

Option 2: Longer retention in existing wetland

A natural wetland is located across Lake Shore Drive from the Chamber of Commerce, just upstream of the inlet location on Cedar Lake. The wetland is approximately 12 acres and would be an excellent location in which to design a weir structure to retain water, sediment and nutrients. Recent experience with IDEM has indicated that they do not permit natural wetlands to be used for storm water treatment. Therefore, this project was considered unfeasible and removed from further consideration. However, enhancement of the existing wetland through select native plantings is possible.

Option 3: Public education program for nuisance wildlife

The source of the E. coli (and likely phosphorus) is probably wildlife and/or pet waste. Some of these pollutants may come from waterfowl use of the natural wetland north of Lake Shore Drive or feeding in adjacent lawns. Public education regarding the disposal of pet waste and feeding of nuisance birds may mitigate these pathogen levels.

This option envisions the development of multimedia materials on problems caused by human feeding of wildlife. The Town already has regulations that prohibit certain kinds of wildlife feeding. An education program to promote these regulations would be beneficial. The Chamber of Commerce site is an excellent location for signs, a kiosk, or other public education facility because of it proximity to Lakeshore Drive and the fact that this site is one of Cedar Lake's public access sites. Other highly visible sites around the lake that are good candidates for a public education program are the Town Hall, the South Shore Country Club, the dam, and Pine Crest Marina. We recommend that more than one site around the lake be included in the program.

4.4.4 Old Bank Building Inlet Improvement Recommendations

Three options for water quality improvements were identified in the Technical Memorandum for this drainage and for further evaluation:

1. Investigate check dams and/or stabilization of banks in the downcutting stream
2. Investigate installation of grass swales and vegetative filters for roadsides and parking

areas

3. Evaluate installation of a detention-based BMP in the open channel east of Morse Street

Option 1: Check dams and/or streambank stabilization

The two channels leading to the Old Bank Building inlet are rather steep and are downcutting in areas along Fairbanks Avenue. The erosion leads to higher loads of suspended solids to Cedar Lake. A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products, placed across a constructed swale or drainage ditch (Figures 8a, 8b, 8c, and 8d). Check dams reduce the slope of the channel, thereby reducing the velocity and erosion potential of flowing water while allowing sediment to settle. Any check dams designed would also require an operations and maintenance program in order to clean out retained sediment and prevent the stream from becoming a terraced drainage channel where the check dams would become overall structures. Bank erosion could also be reduced by rip-rapping, regrading and revegetating, or other techniques.

Option 2: Grass swales and/or roadside vegetative filters

Again, roadsides and parking areas in this drainage contribute much of the suspended soils load. Vegetating these areas, perhaps in combination with traditional or novel curbing and guttering, should reduce the erosion.

Option 3: Detention

The drainage enters a V-shaped artificial channel, approximately 300-feet long, behind the hardware store (Figure 9). The eroding streams along Fairbanks Avenue lead to this channel. Flow enters the channel through a 42-inch culvert. Flow exits through two 36-inch culverts, under Morse Street and (remaining underground) discharges to Cedar Lake. The channel is mowed regularly and appears to be downcutting.

A sanitary sewer pump station and two sanitary sewer manholes exist there, and limit design options for a detention-based BMP. However, design of a wetland is possible. Such a project would require a low-head weir approximately 75 feet upstream of the outlet culvert under Morse Street (Figure 10). Placement of the weir closer to the road would impact the sanitary sewer lines.

A wetland/sediment trap located along 132nd Lane would include a weir, approximately 42 feet in length (Figure 11), earthwork to widen a 200-foot long basin (Figure 12), and native plantings. The weir could be constructed either of steel or plastic sheetpile and be designed to allow minimal impact to normal stream flow. The ponding effects of the weir would be most noted during higher flow events where the weir would cause water to pond behind it and gradually be released. The sediment retention effects of the weir would be most noted during small rainstorms. During events that the weir fills to capacity, the area behind the weir would less than 0.5 acres unless a larger site were to obtained from adjacent landowners. The current conceptual

design only considers construction in the right-of-way owned by the Town of Cedar Lake.

Another potential location for a sediment trap is in a depression along 133rd Street. This location is suitable in that it would require minimal construction. Discussions with the landowner have indicated a willingness of the landowner to work with CLEA. Unfortunately, recent experience suggests that this site would not be permittable under IDEM policies; therefore, the 133rd Street location is considered infeasible and is removed from further consideration.

4.4.5 Golf Course Inlet Improvement Recommendations

The South Shore Country Club is the majority of the area of this inlet. A weir at the edge of the lake controls the volume and flow of water in this inlet. This gate weir can be opened or closed to allow water to pass from this inlet stream to Cedar Lake. Generally the gate is closed and except for wet weather events, the inlet does not export pollutants to Cedar Lake. The South Shore Country uses this weir to regulate the amount of water that is stored in the stream and ponds along this inlet. Water is pumped from the stream and ponds and is used for irrigating the golf course. We interviewed the golf course manager, Mr. John Hayes, to discuss enhancement techniques for this inlet.

Option 1: Golf course management techniques

Mr. Hayes indicated that the golf course is frequently watered but seldom fertilized. In fact, it has been five years since the last fertilizer application. No evidence of erosion rills or channelization from overland flow into the stream and ponds were noted. In fact, the areas around the stream and ponds were well-maintained turfgrass.

Option 2: Streambank stabilization

Mr. Hayes also indicated that he was concerned with the bank stabilization of the stream and ponded areas. The fluctuation in water levels has caused many locations of the banks to slough into the channel and ponded areas. The South Shore Golf Course rip-rapped the banks in areas that were most severely eroding. Additional areas need stabilization. Discussions with Mr. Hayes indicate that he is amenable to additional streambank stabilization and that he would prefer rip-rap to match the areas already protected. Proposed improvement areas are shown in Figure 13 A conceptual design using rip-rap is shown in Figure 14. A modification of this design using erosion control blanket and seeding is also feasible although more maintenance would be likely.

5.0 FEASIBILITY AND DESIGN CONSIDERATIONS

5.1 Hydraulic Analysis

A preliminary hydraulic and hydrologic analysis was performed to further evaluate sediment and nutrient control options within the Old Bank Building and North Point Marina watersheds. This level of analysis is acceptable for a preliminary feasibility analysis; however, a more detailed basin model will need to be developed during the final design and permitting phase. Preferably, the final model should be calibrated against flow monitoring data to confirm the representation of the model to the basin hydrology.

5.1.1 Objectives of the Hydraulic Analysis

The preliminary hydraulic model is based upon existing land use in the Old Bank Building and North Point Marina subwatersheds. This pattern of land use is not expected to change significantly in the near to medium term. Using these simulation conditions, analyses were performed to determine the hydrologic and hydraulic impact of proposed projects to the streams that discharge into Cedar Lake from the Old Bank Building and North Point Marina watersheds.

Suggested structure locations are shown in Figures 3 and 10. These structures would be low-head check dams to provide detention and flow attenuation.

5.1.2 Hydraulic Analysis Methodology

The hydraulic analysis was performed to provide an initial assessment of the potential benefits of the on-stream facilities. Key elements of the analysis included:

- Selection of appropriate design events;
- Characterization of the Old Bank Building and North Point Marina watersheds;
- Definition of drainage sub-basins appropriate for runoff analysis;
- Assignment of sub-basin surface characteristics;
- Development of basin runoff hydrographs using a hydrologic model;
- Development of a hydraulic model representing the stream channel;
- Use of the hydraulic model to assess storage capabilities and water surface levels for the potential projects sites.

Aspects of the model development and application are described below.

5.1.3 Design Event

Engineers characterize rainfall events in terms of their recurrence intervals. The recurrence interval associated with a particular rainfall event is the average period of time that would be

expected between occurrences of that storm when considering a long period of record. For example, a rainfall event with a 10-year recurrence interval has a 10% probability of being equaled or exceeded in any given year. Similarly, an event with a 100-year recurrence interval has a 1% probability of occurring or being exceeded in a given year.

Depth-duration-frequency data for typical Illinois and western Indiana storms are described in the Illinois State Water Survey Bulletin 71 (Huff, 1989). Table 5-1 presents precipitation data for a number of rainfall events and durations. These data were used as design storms for the evaluation of the Old Bank Building and North Point Marina inlet projects. 24-hour storms at multiple return periods were analyzed (Table 5-3). For the analysis of alternatives, a 3rd quartile distribution was selected as the design rainfall distribution. In a third quartile event, the peak intensity of the storm occurs during the third quartile to the storm. For a 24-hour event, this means that the peak intensity occurs between 12 hours and 18 hours after the start of the storm.

Table 5-1

RAINFALL (INCHES) FOR GIVEN RECURRENCE INTERVAL
(Source: Huff, 1989)

Storm Duration	1-year	2-year	5-year	10-year	25-year	50-year	100-year
24-hr	2.42	2.89	3.61	4.22	5.22	6.10	7.12
18-hr	2.27	2.72	3.39	3.97	4.91	5.73	6.69
12-hr	2.11	2.51	3.14	3.67	4.54	5.31	6.19
6-hr	1.82	2.17	2.71	3.16	3.91	4.57	5.34
3-hr	1.55	1.85	2.31	2.70	3.34	3.90	4.56
2-hr	1.40	1.68	2.09	2.45	3.03	3.54	4.13
1-hr	1.14	1.36	1.70	1.98	2.45	2.87	3.35

5.1.4 Watersheds and Runoff

The basin boundaries were determined from topographic maps. Hydrologic parameters were selected to best represent the current characteristics of the drainage sub-basins. Parameters that determine these characteristics include SCS curve number (CN), time-of-concentration, and catchment area. The SCS curve number models the amount of rainfall that becomes runoff in the catchment, with higher numbers corresponding to higher rates of runoff. The time-of-concentration parameter represents the time required for runoff to move across the catchment.

Hydrologic watershed characteristics for existing land use are shown in Table 5-2. While it is recognized that additional development within these areas is likely in the future, it is assumed that the Town's development and detention ordinances will result in effective management of increased stormwater flows. Thus, no dramatic increase in upstream flows to the subwatershed areas is anticipated.

Table 5-2

HYDROLOGIC WATERSHED CHARACTERISTICS[1]

Watershed	Area (acres)	T_c (hours)	T_t (hours)	CN
North Point Marina	166	0.21	0.18	71
Old Bank Building	163	0.17	0.12	81

T_c= Time of Concentration; time required for water to travel overland to the stream (USDA SCS)
T_t = Time of Travel; time required for water to travel via streamflow to the next basin (USDA SCS)

5.1.5 Hydrologic Model of Basin Runoff

Two computer models were used in the preliminary hydraulic analysis: a hydrologic model to compute the rainfall runoff from the watershed and a hydraulic model to compute the water levels and flow rates along the stream channel. This section describes the hydrologic model. The following section describes the hydraulic model.

A hydrologic computer model of the watershed was developed to determine the inflow hydrograph to the proposed wetland locations along the Old Bank Building and North Point Marina inlets. For this analysis, the computer program TR-55 was used to develop the hydrographs. TR-55 was used to calculate peak flows (Q_p) using the SCS method. The SCS method utilizes information on soil storage, as characterized by CNs, to predict the runoff volume resulting from rainfall. A unit hydrograph procedure is then used to distribute the runoff in time (t_c). TR-55 also provides runoff volumes and runoff hydrographs for modeled design storms.

Table 5-3 shows peak discharges at the proposed weirs for a number of different storm events.

Table 5-3

PREDICTED PEAK FLOWS (in cfs)

Subwatershed	1-Year Discharge	2-Year Discharge	5-Year Discharge	10-Year Discharge	25-Year Discharge	50-Year Discharge	100-Year Discharge
North Point Marina	61	91	180	253	384	511	664
Old Bank Building	132	190	288	378	532	667	828

[1] Presented for the 1-year storm. Value changes depending on storm return period.

5.1.6 Verification of the Hydrologic Model

Whenever possible, it is desirable to check hydrologic and hydraulic modeling results against actual measurements of field conditions. This process provides a basis for refinement of the model, and establishes a certain level of confidence in its predictive capability.

The inlet streams from the Old Bank Building and North Point Marina are ungauged streams; therefore, no record of actual flows exist. Also, there is no Flood Insurance Study (FIS) data or stream gauge data for these streams. As a part of the design phase a comprehensive design dependant reanalysis of the entire Old Bank Building and North Point Marina watersheds should be completed in order to verify the flow rates and volumes for these watersheds.

5.1.7 Development/Application of the Hydraulic Model

To route the hydrographs developed with the TR-55 model through the study area, HEC River Analysis System (RAS) Version 2.2 was used (USACE, 1995). HEC-RAS is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels. HEC-RAS Version 2.2 supports steady flow water surface profile calculations. The steady flow component is capable of modeling sub critical, supercritical, and mixed flow regime water surface profiles. The basic computational procedure is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction (Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is utilized in situations where the water surface profile is rapidly varied. These situations include mixed flow regime calculations (i.e., hydraulic jumps), hydraulics of bridges, and evaluating profiles at river confluences (stream junctions). The effects of various obstructions such as bridges, culverts, weirs, and structures can also be modeled. Capabilities are also available for assessing the change in water surface profiles due to channel improvements and levees. Outputs from the HEC-RAS modeling include X-Y plots of the river system schematic, cross-sections, profiles, rating curves, hydrographs, and many other hydraulic variables.

For feasibility-level modeling of the North Point Maria inlet, a series of 5 stream cross section profiles and one culvert or bridge systems were incorporated into the HEC-RAS model. For feasibility-level modeling of the Old Bank Building inlet, a series of 5 stream cross section profiles and two culvert or bridge systems were incorporated into the HEC-RAS model. The HEC-RAS model requires an input of peak flows (Q_ps). A series of Q_ps were calculated based on 24 hour design storms with return periods of 1, 2, 5, 10, 25, 50, and 100 years. Q_ps were calculated using TR-55 as discussed above and displayed in Table 5-3.

5.1.8 Preliminary Hydraulic Modeling Results

Preliminary hydraulic modeling results suggest that with sufficiently sized outflow weirs, the wetland systems pose no concerns of flooding above the desired detention heights. During the design phase, a more comprehensive model which sizes the outlets based on the inlet hydrology,

should be undertaken. Since the systems are restricted to small sizes because of potential land availability restrictions, their most notable contributions are during small and frequent storm event on the order of two-year storms and less. During less frequent, larger storms (> 5 year storms), the systems become inundated and provide minimal changes in stream hydraulics or water quality.

5.1.9 Wetland/Sediment Trap Efficiency

SedBasin (Version 1.0.1 – Hydraulic Analysis for Sedimentation Basin Design) was used to estimate sediment removal rates for the two proposed structures. SedBasin uses basin size, basin length, basin depth, discharge rate, particle size, and particle density to estimate basin removal rates. SedBasin was used to estimate sediment removal rates for different storm events (Table 5-4).

Table 5-4

ESTIMATED SEDIMENT REMOVAL RATES

Storm	Estimated Removal Rates (%)	
	North Point Marina	Old Bank Building
1-yr, 24 hr	61.8	49.6
2-yr, 24 hr	59.6	47.5
5-yr, 24 hr	57.2	46.0
10-yr, 24 hr	56.5	43.2
25-yr, 24 hr	53.8	40.2
50-yr, 24 hr	52.5	38.8
100-yr, 24 hr	50.9	37.5

Sediment removal rates for smaller storms would be higher than those shown in Table 5-4. Nutrient removal rates would be similar to those estimated for sediment.

5.2 Lake Response

The relative effects of alternative lake and watershed management measures on water quality can be estimated using empirical equations, such as those described by Chapra (1997). We took the limiting nutrient approach to lake trophic state evaluation; this approach assumes that reductions in the nutrient source that controls primary production will reduce algae biomass in Cedar Lake. Cedar Lake is a phosphorus-limited system. While Cedar Lake may have historically been impacted by domestic sewage so as to approach nitrogen limitation, loads have been greatly diminished and primary production in the system is now clearly limited by the availability of phosphorus.

Effects on lake water quality were estimated in a two-fold procedure. First, phosphorus loads to

the lake from all sources were estimated using the unit areal loading concept. Then, the loads were routed through the lake using an empirical equation that incorporates the two principal phosphorus sinks in lakes: flushing and sedimentation.

Appendix E provides details of this analysis of project effects on lake water quality. The analysis is based upon unit areal phosphorus loads from defined land use types in each of eight source areas. The source areas were the five subwatersheds being studied in this effort, plus Sleepy Hollow Ditch, Cedar Lake Marsh and the remaining areas. Internal loads from sediment and external loads from atmospheric deposition were included as part of the last source (other).

The sum of all phosphorus loads, under baseline, or current, conditions was estimated to be 9,321 kg/yr, somewhat lower than that estimated in 1999 by Harza. Phosphorus loads under future scenarios were developed from this baseline model.

Table 5-5

CEDAR LAKE PHOSPHORUS LOADS BY SOURCE AREA

Source Area	Load (kg/yr)
Sleepy Hollow Ditch	936
North Point Marina	140
Condos	76
Chamber of Commerce	47
Old Bank Building	115
Golf Course	7.5
Cedar Lake Marsh	1,898
Other	6,102
Total	9,321

Table 5-6

CEDAR LAKE PHOSPHORUS LOADS BY SOURCE TYPE

Source Type	Load (kg/yr)
Urban Land	398
Golf Course	4
Agricultural Land	2,991
Forested Land	49
Wetland	18
Atmosphere	132
Internal to Lake	5,689
On-Site Systems	40
Total	9,321

The benefits of individual lake enhancement measures on lake water quality can be evaluated by routing the above phosphorus loads through the lake. The empirical equation developed by Reckhow and Chapra (1983) solves for the mean annual lake phosphorus concentration (P, in mg/L) based upon annual areal phosphorus loads (L, in g/m^2-yr) and the areal water load (q_s, in m/yr):

$$P = \frac{L}{11.6 + 1.2q_s}$$

Our assumptions for phosphorus removal efficiencies were conservative, in part to account for model uncertainties:

- The wetland proposed for the Old Bank Building subwatershed Sleepy Hollow Ditch would have a phosphorus removal efficiency of 40%
- A wetland at the old railroad embankment in the North Point Marina subwatershed would reduce P loads in that drainage by 25%

These two projects will have minor benefits to lake water quality. The magnitude of the internal P load is so large, that the small reductions attributable to BMPs in the five subwatersheds studied are essentially insignificant. However, if dredging is to occur and remove the internal P load, then these projects' improvements to water quality are much more significant.

5.3 Permit Requirements

Federal, state and local units of government have regulations related to the proposed BMPs, many of which the CLEA is familiar with through the Sleepy Hollow Ditch projects.

5.3.1 Federal Regulations and Permits

Section 404 of the Clean Water Act is the primary federal law regulating the discharge of dredged or fill material to waters of the United States. This law is embodied in federal regulations at 33 CFR Parts 320 through 331. The U.S. Army Corps of Engineers manages the permit program under Section 404 in cooperation with the U.S. Environmental Protection Agency. In Indiana, the Detroit District office issues 404 permits for the Kankakee River drainage.

The Corps' determination of acceptability of any proposed discharge of dredged or fill material considers the probable environmental effect of the proposed discharge on the public interest. This determination typically involves checking compliance with:

- Endangered Species Act
- National Historic Preservation Act
- Fish and Wildlife Coordination Act
- Other federal laws
- State environmental regulations

Section 404 authorizations "Individual Permits" (IP), "Nationwide Permits" (NWP) or "Regional Permits". Projects proposed as part of this study are NWP No. 3 (Maintenance) or No. 27 (Stream and Wetland Restoration Activities).

5.3.2 State Regulations and Permits

The IDEM and the IDNR are the principal state agencies for enforcing state environmental regulations. IDEM is responsible for providing water quality certification for discharges of dredged or fill material under Section 401 of the Clean Water Act. Without Section 401 Water Quality Certification (or a waiver of this certification), the Corps of Engineers is not allowed to issue a Section 404 permit.
Projects requiring a Section 404 permit from the Corps, also require a 401 certification, or a waiver, by IDEM. Using the State's water quality standards as its guide (327 IAC 2), the Department determines if a proposed project will adversely affect the quality of the waters of the State. Under Section 401, the IDEM must act on a certification request within 60 days from the receipt of a complete application.

The Indiana Water Quality Standards (327 IAC 2) include policies of maintenance of existing uses and non-degradation of water quality. IDEM's granting of Section 401 Water Quality

Certification (WQC) indicates that a proposed project will comply with the Standards. Certifications may include limitations, conditions or any other provisions, which IDEM deems necessary to assure that the Standards will not be violated. If IDEM has not given a blanket WQC for a particular NWP, then an individual WQC from IDEM will be necessary. For 404 NWP, the IDEM may have already granted a blanket certification with special conditions.

The IDNR requires a joint permit application for construction within a floodway of a stream or river, navigable waterway, public fresh water lake, and ditch reconstruction. The joint application can be used for: (1) alternation of the bed or shoreline of a public freshwater lake; (2) construction or reconstruction of any ditch or drain having a bottom depth lower than the normal water level of a freshwater lake of 10 acres or more and within ½ mile of the lake; (3) construction within the floodway of any river or stream; (4) placing, filling, or erecting a permanent structure in; water withdrawal from; or material extraction from; a navigable waterway; (5) extraction of mineral resources from or under the bed of a navigable waterway; and (6) construction of an access channel.

The IDEM Rule 5: Storm Water Runoff Associated with Construction Activity, is intended to reduce pollutants in storm water discharges into surface waters of the state. The requirements of Rule 5 apply to all persons who are involved in construction activity that results in the disturbance of one acre or more of land.

A Dam Safety Permit is required by the IDNR if the area of concern meets at least one of the following three requirements: watershed area of 1 square mile and greater, dam height of at least 20 feet, and a detention volume of 100 acre-feet. The drainage area for the potential wetland or sediment trap at 132nd Lane is less than one square mile and would be exempt from this regulation.

5.3.3 Local Permits

The Indiana Drainage Code gives county surveyors authority over "legal drains". None of the five inlets to Cedar Lake are legal drains and are therefore exempt from regulation by the Drainage Board.

Table 5-7

PERMIT REQUIREMENTS

	Vegetative Filters	Detention BMPs	Check Dams	Bank Stabilization
Floodway Permit	n/a if not impacting Waters of the U.S.	If watershed above improvement > 1 mi^2	If watershed above improvement > 1 mi^2	If watershed above improvement > 1 mi^2
401 Certification	n/a	Required	Required	Required
USACE Permit	n/a	NWP 27	NWP 27	NWP 3
IDEM Rule 5	If BMP area > 1 ac	If BMP area > 1 ac	If BMP area > 1 ac	If BMP area > 1 ac
Dam Safety Permit	n/a	n/a	n/a	n/a
Highway Permit	Required if in ROW	Required if in ROW	n/a	n/a
Drainage Permit	n/a	n/a	n/a	n/a

5.4 Project Funding

Appendix F lists a variety of agencies providing funding to individuals and organizations for projects, which address water quality, erosion control, storm water, nonpoint source pollution, wetlands, and wildlife. Funding agencies include the branches of the United States Department of Agriculture (Natural Resources Conservation Service (NRCS) and the United States Forest Service), United States Department of Interior Fish and Wildlife Service, the United States Environmental Protection Agency, and the United States Army Corps of Engineers. Many of these funding agencies provide money to the states, which in turn fund such programs as IDEM's Section 319 Nonpoint Source (NPS) Program. Other programs are financed at the state level, such as the LARE Program.

Not all the programs identified involve grants. Some provide long-term low interest loans to fund particular projects. In general, most of the programs require cost share requirements specifying non-federal contributions from 5 to 75%. There is currently policy and programmatic revisions underway at IDEM that will make non-point source control project eligible for financing by the State Revolving Loan Fund. This is an important new facet of the SRF and presents a significant financial resource for watershed managers in the state.

The most favorable sources of funding have been and likely will continue to be the LARE program, the 319 program and the Build Indiana program. Cedar Lake has had prior success winning grant money from these programs and should continue to explore these programs as

potential funding sources.

5.5 Easements and Land Availability

All projects are proposed for lands outside of the control of the CLEA; therefore, easements will be required. The following are the landowners of interest:

5.5.1 North Point Marina

Development of a detention-based BMP project at the North Point Marina inlet would impact the following landowner:

William and Yvonne Bisset
9114 W. 133rd Street
Cedar Lake, IN 46303

Potential improvements to drainage ditches and manhole inlets, or the installing of curb and guttering will likely occur within the Town of Cedar Lake's street right-of-ways. This could potentially impact some private landowners' properties. This will need to be considered on a case-by-case basis however.

5.5.2 Condos Inlet

Development of a project at the Condos inlet would impact the following landowners:

Ellen Ploetz
8037 Lake Shore Drive
Cedar Lake, IN 46303

Additional impacts would occur on the condominium properties. There are many individual owners for this property. The most effective way to proceed will be through the Condominium Association. The contact for the Condo Association is Mr. Charles Binnie. He can be reached at (219) 746-8067.

Potential improvements to drainage ditches and manhole inlets, or the installing of curb and guttering will likely occur within the Town of Cedar Lake's street right-of-ways. This could potentially impact some private landowners' properties. This will need to be considered on a case-by-case basis however.

5.5.3 Chamber of Commerce Inlet

Any projects involving the large wetland on the north end of Cedar Lake (area which drains through the Chamber of Commerce Inlet) could potentially impact the following landowners:

Alexandra and Bessie Buzanis
2504 W. Gunnison
Chicago, IL 60625

Richard Caldwell
12539 Parrish Ave.
Cedar Lake, IN 46303

Harold and Anne Zimmerman
7914 Lake Shore Drive
Cedar Lake, IN 46303

Potential improvements to drainage ditches and manhole inlets, or the installing of curb and guttering will likely occur within the Town of Cedar Lake's street right-of-ways. This could potentially affect many private landowners. This will need to be considered on a case-by-case basis however.

5.5.4 Old Bank Building Inlet

As mentioned above, a detention BMP is proposed for the channel along 132nd Lane. The Town of Cedar Lake owns the parcel of land. On Center Township Assessor's Office Sidwell Map, the property is identified as Drexel Avenue. According to Tim Brown, Town Manager, the historical parcel system in Cedar Lake assigned road names to streams and valleys and this became the Town's property. Therefore, the proposed location of the BMP is on the Town of Cedar Lake's property. Preliminary discussions with them have indicated that they would be interested in allowing improvements to this ditch/stream. Adjacent property owners that would require notification during the permitting process would include the following:

Mary Louise Adduci
18531 Wentworth
Lansing, IL 60438

Virgil and Marlene Silvea
8133 Howard Ave.
Munster, IN 46321

Charles and Betty Troy
P.O. Box 493
Cedar Lake, IN 46303

Ronald Young, Sr.
6906 W. 133rd Ave.

Cedar Lake, IN 46303

5.5.5 Golf Course Inlet

The stream that runs through the Golf Course watershed is located on the property of South Shore Country Club. According to John Hayes, manager of the Country Club, they would be interested in improvements to the stream if the improvements blended in with the existing stream bank protection that they already have in a number of locations along the stream.

5.5.6 Easements

For those areas where improvements are recommended, landowner easements are included in Appendix G.

5.6 Unusual Physical and/or Social Costs

Through the course of public meetings, residents of Cedar Lake expressed concern that recommended solutions provide not only water quality benefits but also aesthetic benefits. The citizens expressed their desires to have something natural that could blend into and/or complement the existing landscape. The public also expressed concern of flooding that is prevalent throughout areas of the Cedar Lake watershed.

No unusual physical or social costs have been identified for the five small subwatersheds. Including native plantings in detention BMPs or bank erosion controls will add small costs to these projects, less than 15%.

5.7 Subsurface Conditions

At this time, detailed geotechnical investigations are not warranted. Subsurface conditions at the project sites have the potential to impact the design and layout of projects but they do not negate the feasibility of the proposed wetlands or erosion control BMPs. However, it is recommended that a program of borings be used to characterize the subsurface profile and assess normal groundwater levels during the design phase. Soil borings will be needed to determine the types and extent of sub-surface soils present at the site of any proposed improvements. The borings should be logged, and soil samples should be collected at 2.5-foot intervals using a split spoon sampler. The drilled holes, upon completion, should be grouted with a bentonite-cement grout. Soil samples should be selectively analyzed for parameters such as: visual soil classification, moisture content, gradation, Atterberg limits, unconfined compressive strength/in situ density, permeability test, and compaction test.

General classification of soils in the general vicinity of the proposed wetland/sediment traps can be found in the Lake County Soil Survey (Persinger, 1992). This level of description is sufficient for feasibility level analysis. According to the Soil Survey, soils in the North Point Marina

watershed near the proposed site of the wetland include Pewamo silty clay loams and Morley silt loams. The Pewamo series consists of approximately 36 inches of silty clay loam followed by firm silty clay loam till (Persinger, 1992). The Morley series includes approximately 12 inches of silty clay loam followed by silty clay. According to the Soil Survey, soils in the Old Bank Building watershed near the proposed site of the wetland/sediment trap include Morley silt loams and Milford silt loams. The Morley series was introduced above. The Milford series includes approximately 17 inches of silt clay loam followed by silty clay. Based on these general classifications, no complicating geotechnical issues are anticipated.

5.8 Public Education

A public education campaign to reduce nuisance wildlife, most notably Canada geese, should help mitigate *E. coli* and nutrient concentrations in all inlets. This education effort may include information about habitat-friendly landscaping, implications of feeding, water quality problems, and other issues. Brochures, signage or broadcast media could be used. Persuasion campaigns of this type are most effective when they utilize multiple channels, come from multiple sources, and target multiple groups.

While some wildlife feeding ordinances exist around the country, few are seriously enforced, and there are few significant education campaigns to discourage feeding aside from some passive signs at popular feeding areas. This recognizes that considerably more could be done to discourage a behavior that generally works to decrease wildlife diversity, may harm individual animals (who eat less nutritionally-rich foods, may lose their ability to secure natural food, and may alter their natural migration patterns), attracts wildlife concentrations that can become a nuisance, adversely affect natural wildlife behavior, and pollute surface water.

At this point, we recommend signage at public access sites and public parks on the lake, and a brochure be developed regarding feeding of waterfowl. The brochure can be distributed at the Chamber of Commerce, Town Hall, CLEA meetings and fundraising events, and can be posted to the CLEA's web site. For feasibility level purposes, we estimate $5,000 to initiate this public education program.

5.9 Environmental Assessment

We have opted to mimic the guidelines of the U.S. Environmental Protection Agency's Clean Lakes Program in order to assess the environmental effects of proposed projects in the five small subwatersheds. These guidelines involve a checklist approach to impact assessment and can be found at 40 CFR, Part 35, Subpart H. These guidelines involve 14 questions that may be satisfactorily answered with a mere "Yes" or "No", but should detail important benefits or adverse effects sufficiently to allow for mitigation planning during the design and implementation phases.

Appendix H provides the results of the Environmental Assessment. None of the proposed

projects have significant adverse effects on the physical, biological or social environment. The small scale of the proposed projects limit their adverse effects on environmental resources.

We conducted surveys of vegetation at four sites being studied (Appendix G) and applied the Swink and Wilhelm Floristic Quality Assessment methodology. For a detailed discussion of this methodology see Swink *et al.* (1994). The Floristic Quality Assessment is a means of evaluating the vegetative quality of a site in relation to natural, or native, vegetative quality. Fundamental to this assessment is the assignment of a Coefficient of Conservatism value, C, to each native species in the plant community. The C value varies from 0 ("weedy") to 10 ("conservative") and reflects a species relationship to an unaltered area with a natural plant community. Table 5-8 summarizes the vegetation community data for the four sites surveyed: the ditch at the Condos Inlet, the ditch along 132nd Lane in the Old Bank Building, an eroding stream channel at 133rd and Fairbanks, and a wetland area in the North Point Marina drainage. All of the sites have been extensively disturbed and have little natural significance. In highly disturbed settings such as these, this analysis may actually overestimate vegetation quality because exotic species with no C value are present at each of the sites. Such plant species are not given C values because they were not part of the Chicago region's plant communities prior to European settlement. They exist on a site because of past disturbance (clearing and grading) and/or because they are aggressive invaders that push out the natural plant species.

Table 5-8

FLORISTIC QUALITY SUMMARY

	Condos Inlet	132nd Lane	133rd & Fairbanks	No Pt Marina
Total Plant Species	14*	14*	17	19
Number of Native Plant Species	6	6	9	12
Mean "C"	2.2	2.8	3.1	2.4
FQI	5.3	6.9	9.3	8.4

*Does not include unidentified lawn grasses.

The Floristic Quality Index (FQI) is an indicator of the significance of the plant community in relation to a native plant community. The higher the FQI the closer the plant community is to a native plant community. Areas with FQI values of less than 20 are extensively disturbed and have little natural significance. The very low FQI of the Cedar Lake sites indicates that they are extensively disturbed and bear little resemblance to native vegetation communities.

5.10 Costs

Budgetary cost estimates for the alternative lake enhancement projects are provided in Tables 5-9

through 5-16. These tables provide preliminary estimates of cost for development, and include a reasonable level of contingency. All excavation and disposal prices assume a disposal site within three miles of removal.

Table 5-9 presents estimates for general recommendations in this study.

Table 5-9

BUDGETARY COST ESTIMATE FOR WATERSHED IMPROVEMENTS

Item	Unit Cost
Curb and Guttering	
Straight sections; forms, concrete and labor	$20 / LF
Curved sections; forms, concrete and labor	$22 / LF
Grass swales, roadside vegetation filters, and culvert outlet protection	
Erosion control blanket; furnished and installed	$2.50 / SY
Spot grading with Bobcat	$60 / hr
Sod; furnished and installed	$0.30 / SF
Seeding; furnished and installed	$0.20 / SY
Rip-rap (10 to 100 lb pieces); furnished and installed	$36 / CY

5.10.1 Condos Inlet

Two alternatives were examined in this feasibility study for the Condos inlet. These alternatives included a detention-based BMP in the open channel just upstream of the lake, and grass swales, vegetative filters for roadsides and parking areas, and culvert outlet protection. Given the small area available for a BMP in the open channel, this option was considered unfeasible, and removed from consideration. Budgetary costs for grass swales, vegetative filters for roadsides and parking areas, and culvert outlet protection are presented above in Table 5-9. Two other options have been added at the request of the CLEA during the second public meeting. During the course of this study, the steep streambank of the open channel area of this inlet near Cedar Lake has failed. Two options were considered to improve this area: 1) extension of the storm sewer to Cedar Lake (Table 5-10), and 2) stabilization of the failing streambank (Table 5-11).

Table 5-10

BUDGETARY COST ESTIMATE FOR INSTALLATION OF STORM SEWER

Item	Quantity	Unit	Unit Cost	Total Cost
Pipe, furnish and install	120	LF	$54.56 / LF	$6,550
Backfill, furnish and place	111	CY	$4 / CY	$450
Mobilization / Demobilization	1	LS	$1,000	$1,000
Site Restoration, Sod	960	SF	$0.30 / SF	$300
Engineering, permitting and conceptual design	1	LS	$3,000	$3,000
Subtotal				**$11,300**
Contingency (@25%)				$2,800
ESTIMATED TOTAL				**$14,100**

Table 5-11

BUDGETARY COST ESTIMATE FOR STREAMBANK STABILIZATION

Item	Quantity	Unit	Unit Cost	Total Cost
Excavation by backhoe	115	CY	$4.50 / CY	$520
Loading and hauling of excavation spoils to dump site	115	CY	$5.70 / CY	$650
Gabions, 12 inch width stone filled	215	SY	$31.70 / SY	$6,800
Site Restoration, sod	3120	SF	$0.30 / SF	$950
Mobilization / Demobilization	1	LS	$1,000	$1,000
Engineering, permitting and conceptual design	1	LS	$3,000	$3,000
Subtotal				**$12,900**
Contingency (@25%)				$3,200
ESTIMATED TOTAL				**$16,100**

Another alternative discussed in this feasibility study was the installation of a CDS unit. These costs from $10,000 to $50,000 for high level flows up to 200 CFS. A system installed at the outlet near the lake would cost approximately $25,000 to $40,000 if it was designed for a "first flush" storm with return frequency on the order of three to nine months.

5.10.2 North Point Marina Inlet

Two alternatives were examined for the North Point Marina subwatershed. They included a detention-based BMP in the open channel just upstream of the railroad embankment (Table 5-12), and grass swales and vegetative filters for roadsides and ditch. Budgetary costs for grass swales and erosion protection have been presented above in Table 5-9.

Table 5-12

BUDGETARY COST ESTIMATE FOR CONSTRUCTED WETLAND

Item	Quantity	Unit	Unit Cost	Total Cost
Excavation / grading	1,000	CY	$4.50 / CY	$4,500
Vinyl sheetpile weir, furnish and install	500	SF	$17 / SF	$8,500
Rip-rap for erosion control, furnish and install	7	CY	$36 / CY	$250
Wetland / tree planting	1	LS	$3,000	$3,000
Site Restoration	1	LS	$1,000	$1,000
Mobilization / Demobilization	1	LS	$3,000	$3,000
Engineering; permitting, design, and specifications	1	LS	$15,000	$15,000
Subtotal				**$35,250**
Contingency (@25%)				$8,800
ESTIMATED TOTAL				**$44,050**

5.10.3 Chamber of Commerce Inlet

Three alternatives were looked at in this feasibility study for the Chamber of Commerce inlet. They included evaluation of: grass swales and vegetative filters for roadsides and ditch, enhancements to promote longer retention in the existing wetland, and a public education program for nuisance wildlife. Costs for grass swales and erosion protection have been presented above in Table 5-9. Longer retention in the existing natural wetland has previously been considered not feasible because of permitting concerns and therefore a cost is not developed for this option. A public education program for nuisance wildlife is estimated to cost approximately $5,000. It is envisioned that this would include adding signage around this area, and promoting the efforts through handouts, public meetings, the newspaper, and the Internet. If native plantings are installed in the existing natural wetland, they cost approximately $5 per plant on average when installed.

5.10.4 Old Bank Building Inlet

Three alternatives were evaluated for the Old Bank Building subwatershed. They included: grass swales and vegetative filters for roadsides and ditch, a detention-based BMP in the open channel east of Morse Street (Table 5-13), and installation of check dams and/or stabilization of banks in the downcutting stream (Table 5-14). Budgetary costs for grass swales and erosion protection have been presented above in Table 5-9.

Table 5-13

BUDGETARY COST ESTIMATE FOR DETENTION BMP

Item	Quantity	Unit	Unit Cost	Total Cost
Excavation by backhoe	1,050	CY	$4.50 / CY	$4,725
Loading and hauling of excavation spoils to dump site	1,050	CY	$5.70 / CY	$6,000
Vinyl sheetpile weir, furnish and install	420	SF	$17 / SF	$7,150
Rip-rap for erosion control, furnish and install	7	CY	$36 / CY	$250
Wetland / tree planting	1	LS	$3,000	$3,000
Site Restoration	1	LS	$1,000	$1,000
Mobilization / Demobilization	1	LS	$3,000	$3,000
Engineering; permitting, design, and specifications	1	LS	$15,000	$15,000
Subtotal				**$40,125**
Contingency (@25%)				$10,000
ESTIMATED TOTAL				**$50,125**

Table 5-14

BUDGETARY COST ESTIMATE FOR STREAMBANK STABILIZATION

Item	Unit Cost
Check Dams	
Gabion baskets, 1 foot width (assume 2 –1'x2'x12' structures per check dam)	$50 / SY[2] → $300 per check dam[3]
Streambank Protection Options	
Coir fiber roll toe protection	$45 per foot
Stone toe protection	$60 per foot
Coir fiber matting protection	$5 per foot
Live stake installation (3-4 rows)	$8 per foot
Hard armoring (gabions, sheetpile, hydrotex)	>$100 per foot

5.10.5 Golf Course Inlet

One structural alternative was evaluated for the Gold Course inlet. It included reviewing installation of vegetative or structural bank protection. The vegetative method assumed flattening of slopes, placement of high quality erosion control matting, and seeding of the area.

5.10.5.1 Streambanks North of 145th Avenue

There are approximately 1,200 linear feet of eroding streambanks along the Golf Course inlet on

[2] Higher unit cost than presented before because structures will need to be built with smaller equipment. If conditions preclude construction with equipment, double costs.
[3] Structures will require conceptual design and permitting

this side of the road.

Table 5-15

BUDGETARY COST ESTIMATE FOR EROSION CONTROL MATTING

Item	Quantity	Unit	Unit Cost	Total Cost
Excavation by backhoe	300	CY	$4.50 / CY	$1,350
Loading and hauling of excavation spoils to dump site	300	CY	$5.70 / CY	$1,710
Erosion control matting, furnish and install	720	SY	$2.50 / SY	$1,800
Seeding	720	SY	$0.20 / SY	$150
Mobilization / Demobilization	1	LS	$1,000	$1,000
Engineering; permitting and conceptual design	1	LS	$3,000	$3,000
Subtotal				**$9,000**
Contingency (@25%)				$2,250
ESTIMATED TOTAL				**$11,250**

Table 5-16

BUDGETARY COST ESTIMATE FOR RIP-RAP

Item	Quantity	Unit	Unit Cost	Total Cost
Excavation by backhoe	300	CY	$4.50 / CY	$1,350
Loading and hauling of excavation spoils to dump site	300	CY	$5.70 / CY	$1,710
8" thick layer of rip-rap (10 to 100 lb pieces); furnish and install	181	CY	$36 / CY	$6,500
Filter fabric	720	SY	$1 / SY	$720
Mobilization / Demobilization	1	LS	$1,000	$1,000
Engineering; permitting and conceptual design	1	LS	$3,000	$3,000
Subtotal				**$14,300**
Contingency (@25%)				$3,600
ESTIMATED TOTAL				**$17,900**

5.10.5.2 Streambanks South of 145th Avenue

There are approximately 1,800 linear feet of eroding streambanks along the Golf Course inlet on this side of the road. Installation of erosion control matting will cost approximately $17,000, while installation of rip-rap will cost approximately $27,000.

5.11 Recommendations

Feasibility analysis indicates that detention BMPs in the North Point Marina inlet watershed and the Old Bank Build inlet watershed can:

- reduce stream velocities without significantly raising upstream flood elevations

- reduce sediment and nutrient loading into Cedar Lake
- reduce floodplain loss from stream bank erosion and resulting stream widening

Additionally, watershed-based BMPs and/or land use practices can improve water quality and aesthetics.

A summary of all options studied is presented in Table 5-17. The following options are recommended.

- Detention BMPs, as constructed wetlands are recommended for the North Point Marina and Old Bank Building inlets at the locations detailed in this study. These systems will provide for removal of sediment and associated pollutants from upstream areas. Wetland treatment systems in these areas will also provide some minimal wildlife habitat and aesthetic values. The combined design/construction cost of these two measures is about $94,000 and will constitute measurable reductions in non-point source pollution from these two watersheds.
- A number of watershed BMPs have been determined feasible throughout the watershed. These should be implemented as fund allows.
- The streambank at the Condos inlet should be addressed before further failure. The least costly option is extending the storm sewer pipe to Cedar Lake. Other feasible but more costly options include streambank stabilization, or streambank stabilization in conjunction with a sediment trap. Inlet sediment control, using a CDS unit, is also proposed.
- The streambanks at the Golf Course inlet can be addressed relatively easily through vegetative and rip-rap designs. However, either of these options is relatively expensive as the slopes are steep and have to be flattened in order for either of these techniques to be effective.
- Native vegetation planting in the natural wetland in the Chamber of Commerce inlet.

To finance these recommended projects, the most promising funding sources are the LARE Program, the Build Indiana Fund, and the IDEM 319 fund. We recommend that the CLEA apply to each of these sources for funding design, construction, and implementation assistance.

Table 5-17

SUMMARY TABLE

	North Point Marina		Condos Inlet			
	Grass Swale / Vegetative Filter	Constructed Wetland	Grass Swale / Vegetative Filter	In-Stream BMP	Bank Stabilization	Culvert Extension
Capital Costs	Design dependant, see Table 5-9	$44,000	Design dependant, see Table 5-9	Not Feasible	$16,100	$14,100
Lake Response						
Number of Permits	0[4]	3	0[4]		3	3
No. Affected Landowners	Unknown[5]	1	Unknown[5]		2	2
Environmental Concerns	Minor	Minor	Minor		Minor	Minor
Unusual Social Costs	None	Near railroad R.O.W.	None		None	None
Flooding Concerns	None	None, Ponded water	None		None	None

[4] It is assumed that these improvements will occur in roadside ditches and not Waters of the United States. Otherwise permitting will be required. If improvements impact highway ROWs, a permit or authorization will be required.

Table 5-17

SUMMARY TABLE (Cont.)

	Chamber of Commerce Inlet			Old Bank Building		
	Grass Swale / Vegetative Filter	Wetland Enhancement	Nuisance Wildlife Public Education	Grass Swale / Vegetative Filter	Check dams / Streambank stabilization	Constructed Wetland
Capital Costs	Design dependant, see Table 5-9	Not Feasible	$5,000	Design dependant, see Table 5-9	Design dependant, see Table 5-9	$50,000
Number of Permits	0[4]		N/a	0[4]	3	3
No. Affected Landowners	Unknown[5]		N/a	unknown[5]	Unknown[5]	1 to 3[5]
Environmental Concerns	Minor		Minor	Minor	Minor	Minor
Unusual Social Costs	None		None	None	None	Near sanitary sewer
Flooding Concerns	None		None	None	None, Ponded water	None, Ponded water

	Golf Course Inlet					
	Vegetative Streambank Protection	Structural Streambank Protection				
Capital Costs	$28,000	$45,000				
Number of Permits	3	3				
No. Affected Landowners	1	1				
Environmental Concerns	Minor	Minor				
Unusual Social Costs	None	None				
Flooding Concerns	None	None				

[5] Depends on BMP used and location (i.e. design dependant)

6.0 ACTION PLAN AND SCHEDULE

Overall the implementation of these projects will have several step-wise components:

- An application for design grants will be prepared and submitted to the LARE office in January 2004.

- July 2004 is when notice will be provided to whether a grant has been received. If the design grant is approved, field investigations and related analyses should be quickly performed. These efforts are needed to determine final design considerations including soils, surveying, and hydraulic impacts. This information is also needed to facilitate approval of permits. Materials compiled in this stage of effort should be used to make submittals to permitting agencies.

- A key element of implementation involves property owner coordination. Agreements must be reached among the individual property owner(s) before any improvements can be implemented.

- The last element of the implementation action plan is design of the improvement measures. This effort will focus on the design and the preparation of bid documents for the project.

- Following completion of the project design documents and the bid tendering, the project will be constructed.

The implement steps may vary slightly from the schedule described above depending on local decisions related to the configuration of the facilities, permitting issues, or other factors. The following tasks are recommended:

1. Property Owner(s) Coordination (July 2004). Acceptance of the proposed plan by affected property owner(s) will be critically important to successful and timely project implementation. Using the concepts in this study, the CLEA should continue discussions with property owners in the project area. These discussions should focus on the likely timing of developments and the need for individual owners to commit land area to the project. Results of these discussions will directly impact the final configuration of the proposed improvement.

2. Detailed Hydraulic Analysis/Flow Monitoring (Fall and Winter 2004). Analyses conducted for this study indicate that there is no FIS data for the inlets of interest. For those inlets where wetland/sediment traps are proposed (Old Bank Building and North Point Marina inlets), permitting agencies will potentially require that analyses be conducted to clearly demonstrate how the proposed improvements will function during a range of possible storm events. Therefore, additional more detailed hydrologic and hydraulic modeling of the inlet watershed will need to be performed. This will require surveying in and around the proposed

wetland/sediment trap location. This modeling effort will provide the basis for obtaining critical water resources permits from the IDNR. Key elements of the modeling task will include refining of the hydrologic model of the watershed upstream of the project site based on designed inlet and outlet sizes and controls.

3. Subsurface Investigations (Fall or Winter 2004). Subsurface conditions at the project site have the potential to impact the design and layout of the proposed wetland/sediment traps. Therefore, it is recommended that a program of borings be used to characterize the subsurface profile and assess normal groundwater levels. Soil borings will be needed to determine the types and extent of sub-surface soils present at the site of any proposed improvements. The borings should be logged, and soil samples should be collected at 2.5-foot intervals using a split spoon sampler. The drilled holes, upon completion, should be grouted with a bentonite-cement grout. Soil samples should be selectively analyzed for parameters such as: visual soil classification, moisture content, gradation, Atterberg limits, unconfined compressive strength/in situ density, permeability test, and compaction test.

4. Detailed Design of Improvements (Winter 2004 / Spring 2005). In order for the construction of the proposed improvements to be completed during 2005, detailed design documents for the project will have to be completed during the winter and early spring in parallel with permitting efforts. Critical design plans to be prepared include drawings for the berm, grading and excavation plans for the storage basin, and site restoration plans. Details related to sensitive areas and provisions for effective erosion and sediment control measures will also be required. A detailed site survey will be required to develop accurate topography for the design and to establish appropriate control points for the construction effort.

5. Grant Application (January 2005). In order to have sufficient funds to construct the designed improvements, CLEA should apply to the IDNR LARE and IDEM 319 Program, and the Build Indiana Fund in order to secure sufficient funds to construct the designed improvements.

Table 6-1

ESTIMATED WATERSHED IMPROVEMENT SCHEDULE

Design Phase

LARE Grants Awarded	July 2004
Detailed Design and Engineering	October 2004 - June 2005
Surveying	November 2004
Geotechnical Sampling and Analysis	January 2005
Construction Grant Applications	January 2005

Construction Phase

Land Acquisition	July 2004 - November 2004
Grant Award	July 2005
Mobilization	October 2005
Sediment Trap Excavation	October 2005
Weir Construction	November 2005
Landscape Preparation	November 2005

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Figures

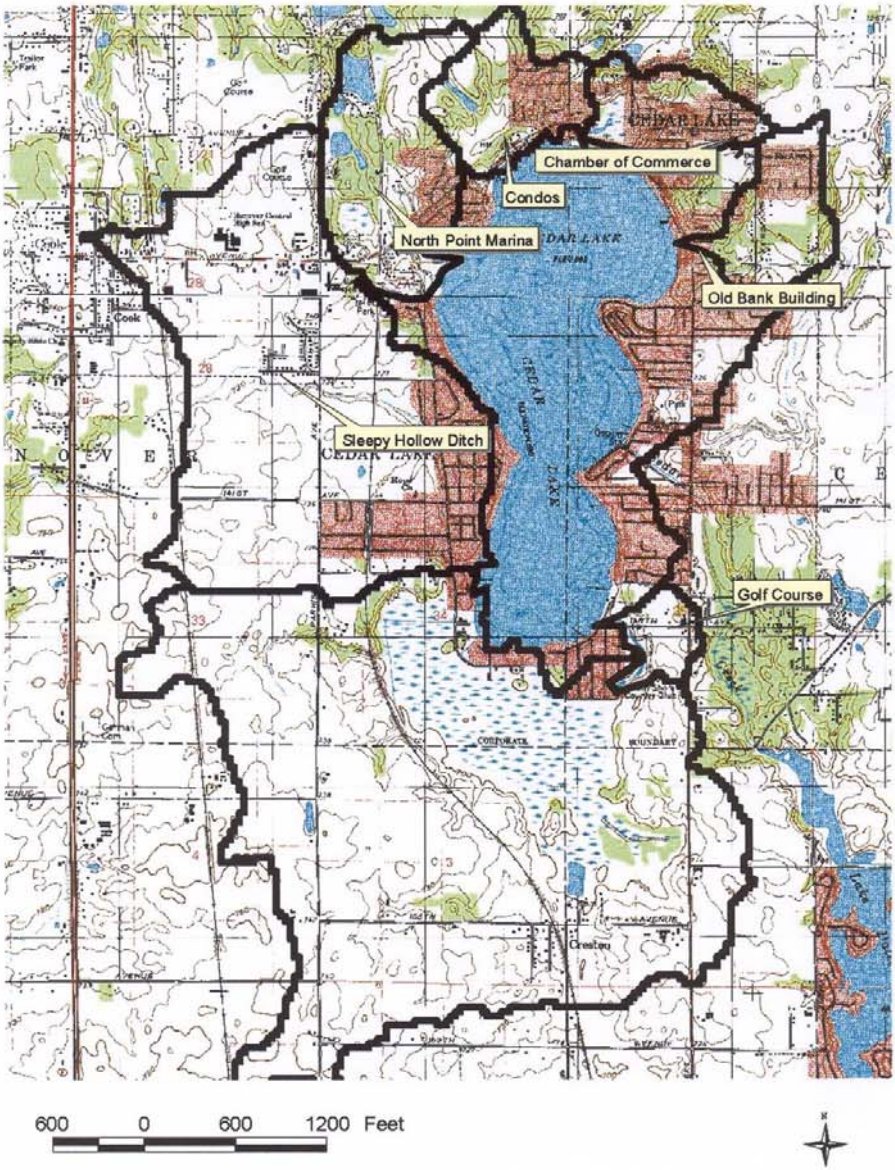
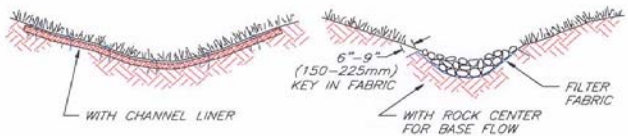
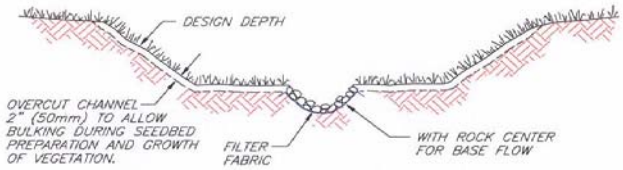


Figure 1
Site Location Map
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana



TYPICAL PARABOLIC CHANNEL
CROSS-SECTION



(Adapted from Salix Applied Earthcare, 1999)

Note: The choice of rock-lined and/or grass-lined channels will be based on site-specific conditions determined during design activities.

Figure 2
Watershed Best Management Practice – Grass Swales
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana

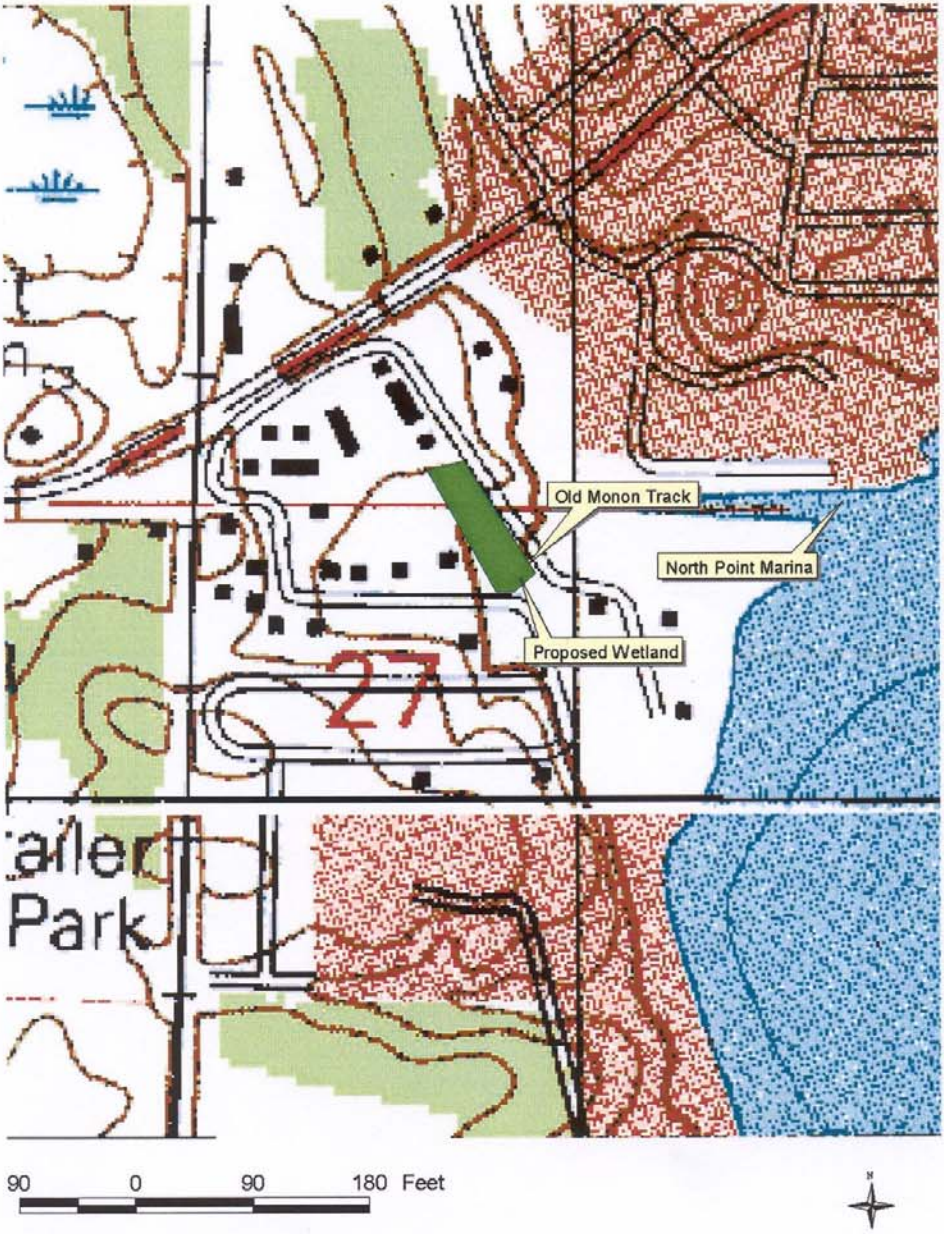


Figure 3
North Point Marina Inlet Proposed Wetland Location
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana

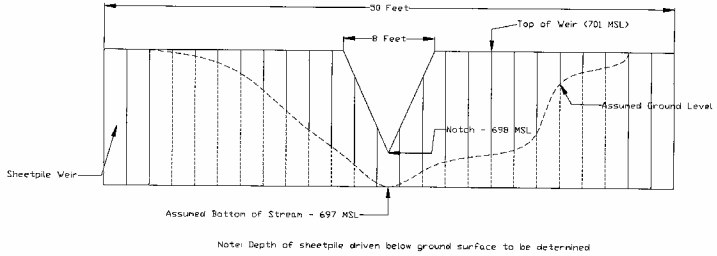
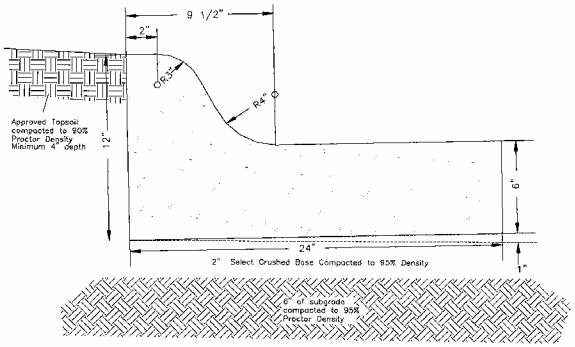


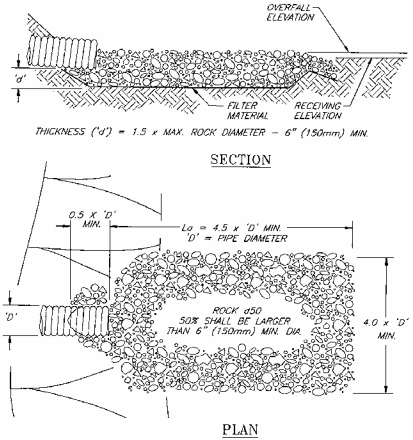
Figure 4
North Point Marina Inlet Conceptual Wetland Weir Design
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana



1. Contraction joints shall be placed every 10 feet and shall be 3/4" deep
2. Expansion joints of 1/2" mastic material shall be placed at the following locations:
   P.C.s and P.T.s of curves
   Grade breaks
   4' on either side of a drainage structure
   At other locations as specified by engineer
3. Construction materials and proceedures shall conform to existing City and State Standard Specifications.

(Adapted from Salix Applied Earthcare, 1999)

Figure 5
Watershed Best Management Practice – Curb and Guttering
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana

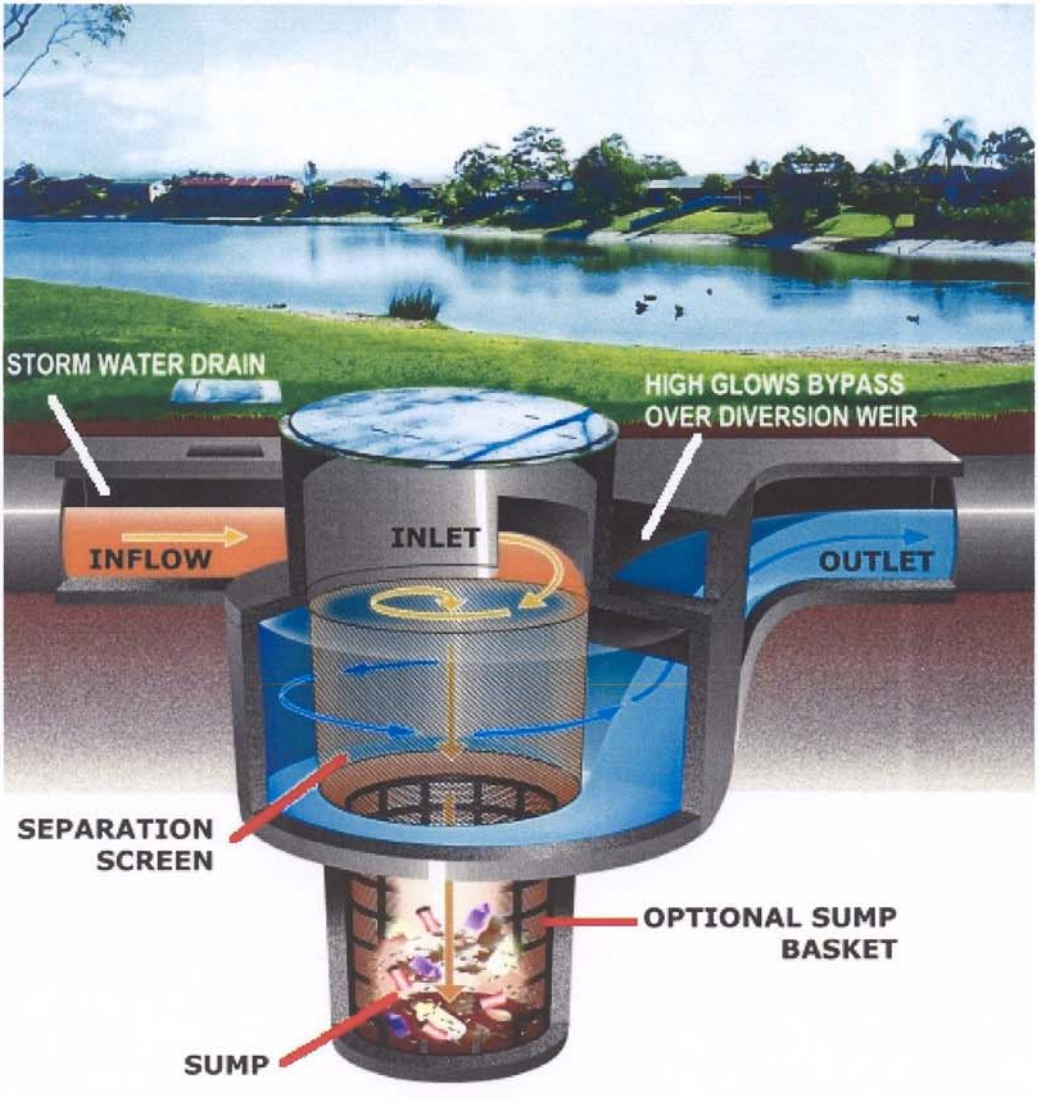


NOTES:

1. 'Lo' = LENGTH OF APRON. DISTANCE 'Lo' SHALL BE OF SUFFICIENT LENGTH TO DISSIPATE ENERGY.
2. APRON SHALL BE SET AT A ZERO GRADE AND ALIGNED STRAIGHT.
3. FILTER MATERIAL SHALL BE FILTER FABRIC OR 6" (150mm) THICK MINIMUM GRADED GRAVEL LAYER.

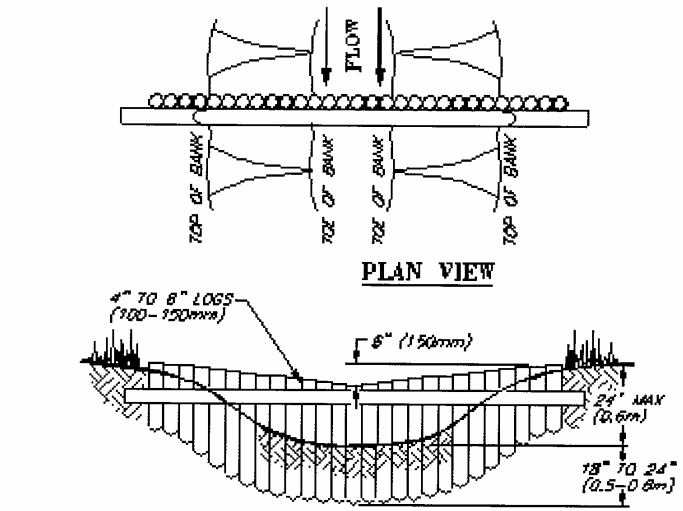
(Adapted from Salix Applied Earthcare, 1999)

Figure 6
Watershed Best Management Practice – Culvert Outlet Protection
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana



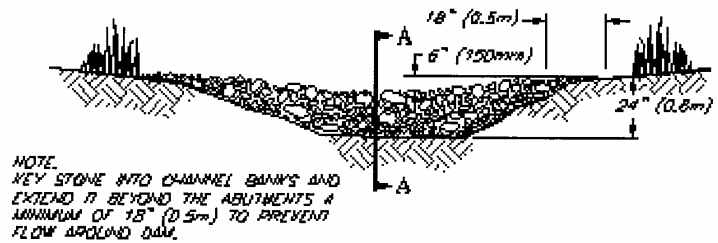
(Source is www.cdstech.com)

Figure 7
Continuous Deflective Separation Unit Schematic
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana

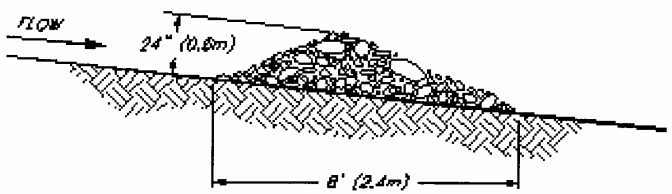


(Adapted from Salix Applied Earthcare, 1999)

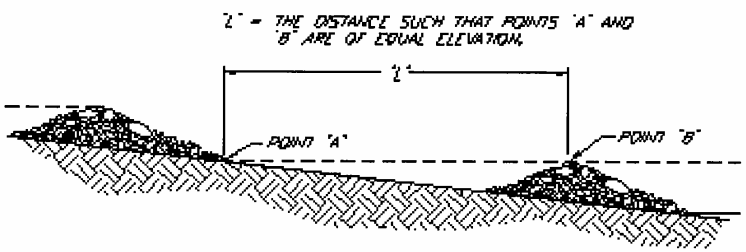
Figure 8a
Log Checkdams – Conceptual Design
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana



VIEW LOOKING UPSTREAM



SECTION A – A

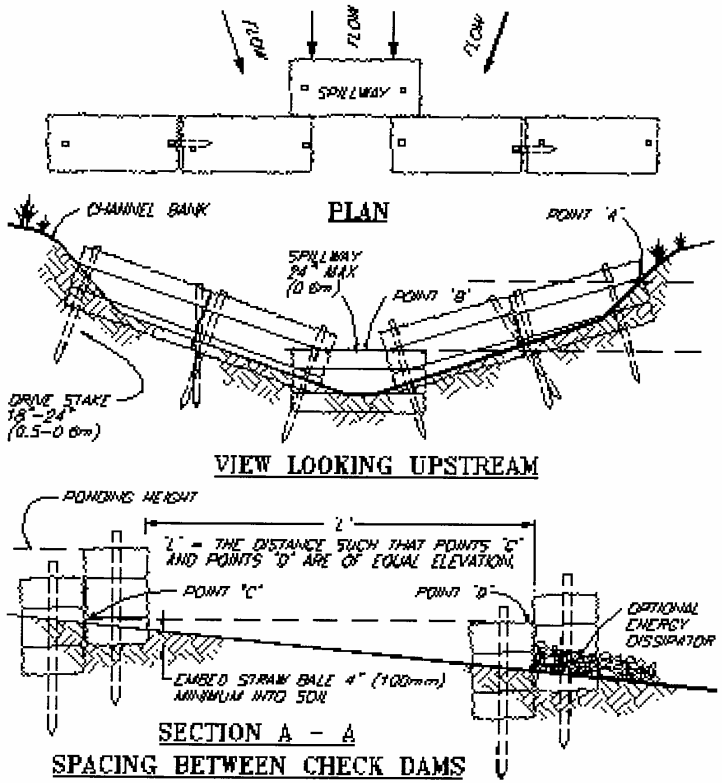


SPACING BETWEEN CHECK DAMS

NOT TO SCALE

(Adapted from Salix Applied Earthcare, 1999)

Figure 8b
Rock Checkdams – Conceptual Design
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana



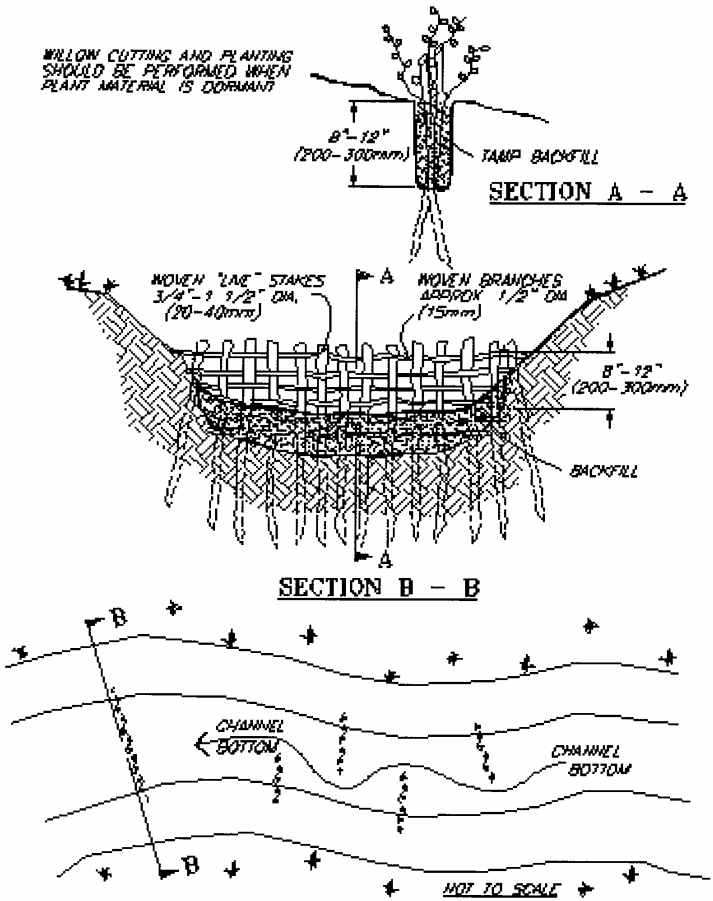
NOTES:

1. EMBED BALES 4" (100mm) INTO THE SOIL AND "KEY" BALES INTO THE CHANNEL BANKS.
2. POINT 'A' MUST BE HIGHER THAN POINT 'B'. (SPILLWAY HEIGHT)
3. PLACE BALES PERPENDICULAR TO THE FLOW WITH ENDS TIGHTLY ABUTTING.
4. SPILLWAY HEIGHT SHALL NOT EXCEED 24" (0.6m).
5. INSPECT AFTER EACH SIGNIFICANT STORM. MAINTAIN AND REPAIR PROMPTLY.

NOT TO SCALE

(Adapted from Salix Applied Earthcare, 1999)

Figure 8c
Straw Bale Checkdams – Conceptual Design
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana



WOVEN WILLOW (LIVE) CHECKDAMS ACT AS VELOCITY DISSIPATORS TO REDUCE GULLY DOWNCUTTING

(Adapted from Salix Applied Earthcare, 1999)

Figure 8d
Woven Willow Checkdams – Conceptual Design
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana

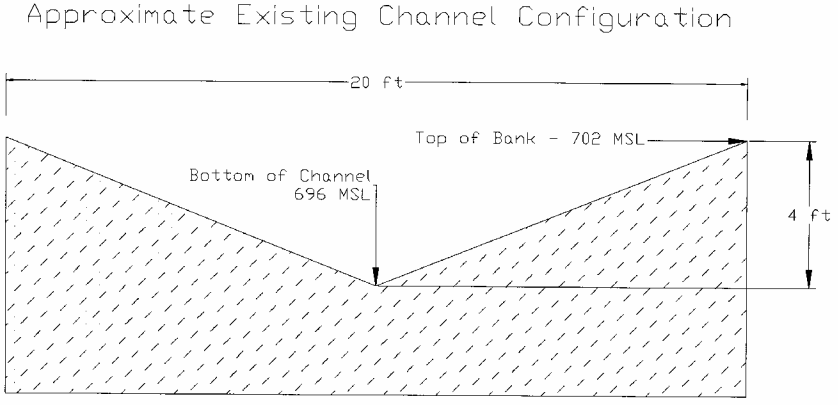


Figure 9
Old Bank Building Inlet Existing Channel Configuration
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana

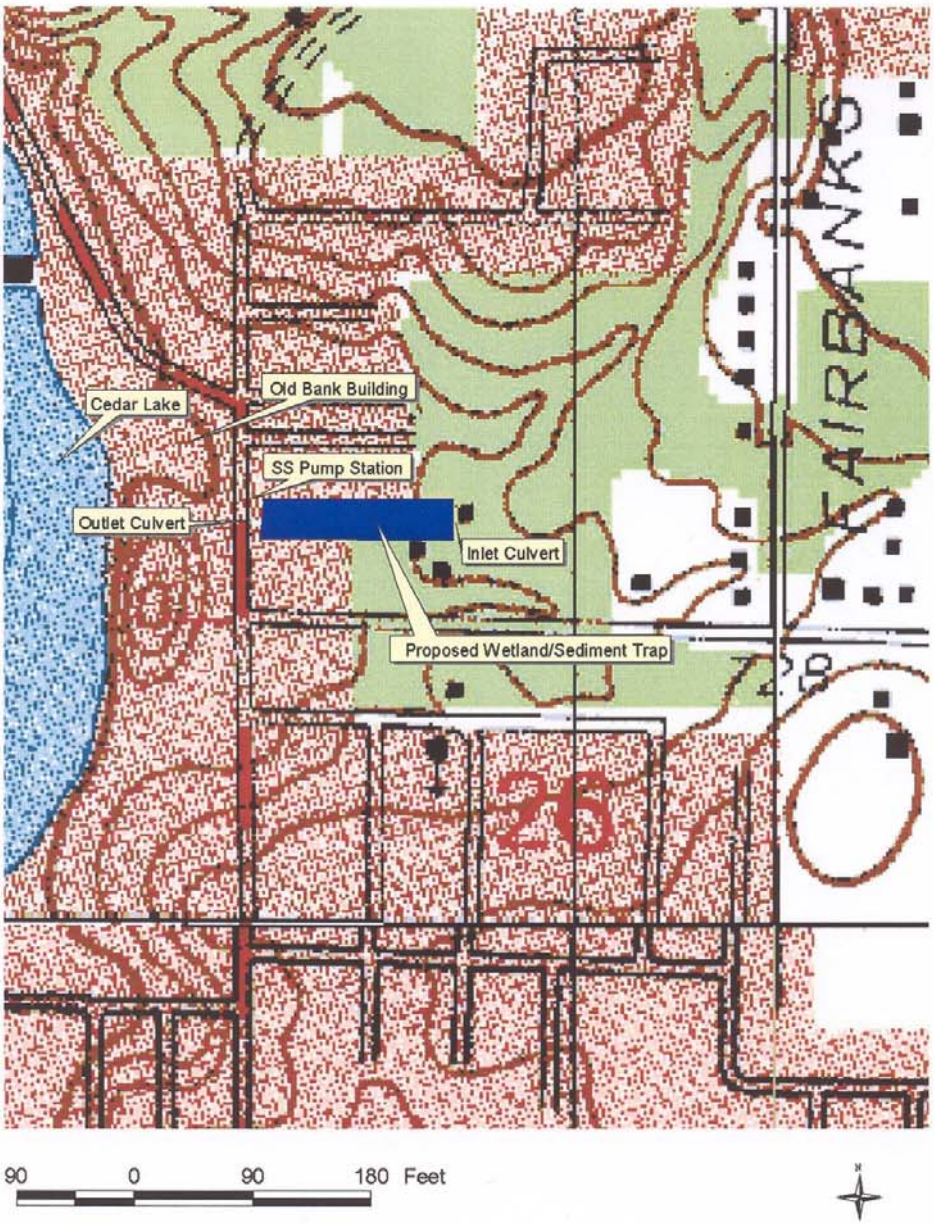


Figure 10
Old Bank Building Inlet Proposed Wetland Location
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana

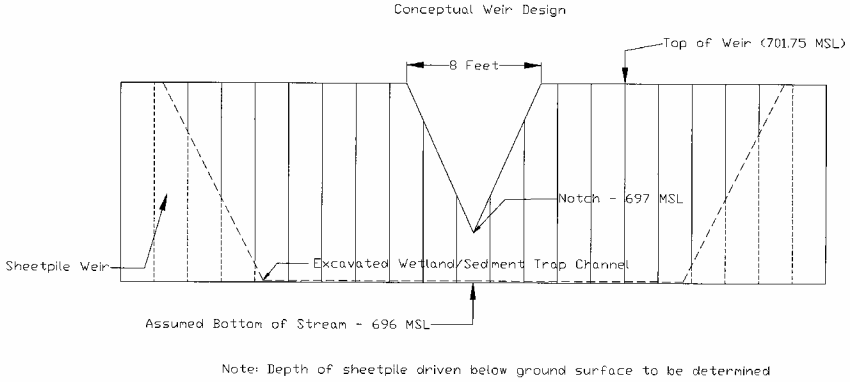
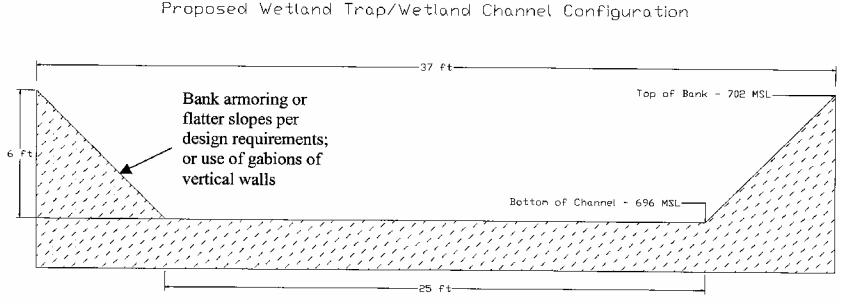


Figure 11
Old Bank Building Inlet Conceptual Wetland Weir Design
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana



Note: Vegetation to be plugged in channel and likely on channel slopes.

Figure 12
Old Bank Building Inlet Conceptual Wetland Configuration
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana

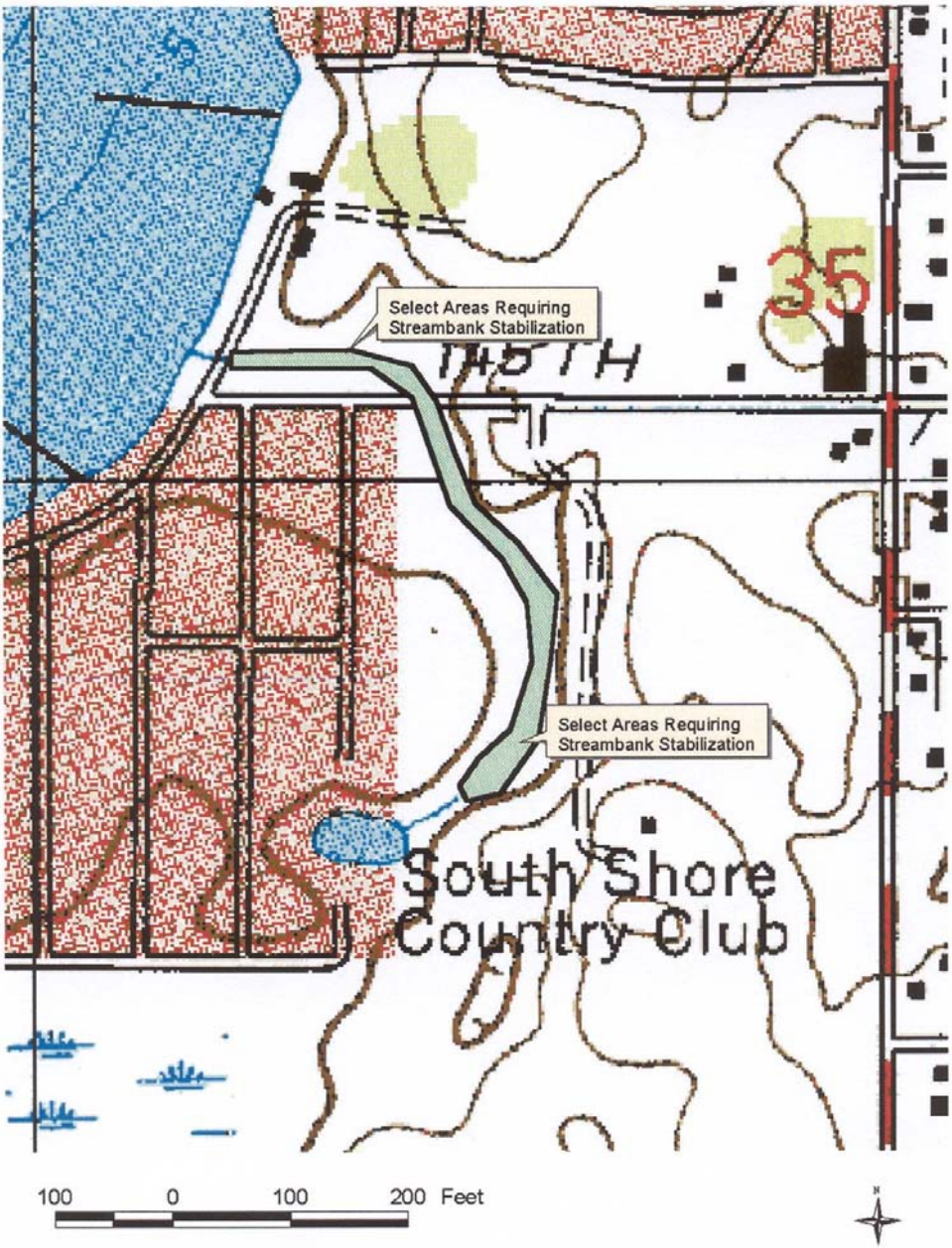
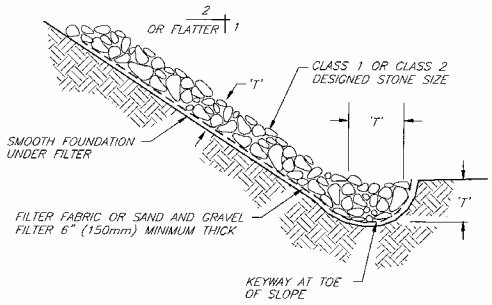


Figure 13
Golf Course Inlet Proposed Stabilization Areas
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana



TYPICAL SECTION

NOTE:
'T' = THICKNESS: THICKNESS SHALL BE DETERMINED BY THE ENGINEER.

MINIMUM THICKNESS SHALL BE 1.5x THE MAXIMUM STONE DIAMETER, NEVER LESS THAN 6" (150mm).

(Adapted from Salix Applied Earthcare, 1999)

Figure 14
Golf Course Inlet Conceptual Streambank Stabilization
Cedar Lake Engineering Feasibility Study
Cedar Lake, Indiana

Appendix A

Frank O'Bannon, Governor
John Goss, Director

DNR Indiana Department of Natural Resources

Environmental Unit
Division of Water
402 W. Washington Street, Rm. W264
Indianapolis, IN 46204-2641

7 August 2003

Mr. Douglas L. Mulvey, P.E.
EnviroForensics
33 North LaSalle, Suite 2119
Chicago, Illinois 60602

Re: DNR #10337 - Request for Environmental Information, Cedar Lake; Lake County

Dear Mr. Mulvey:

The Indiana Department of Natural Resources has reviewed the above referenced project per your request. Our agency offers the following comments for your information and in accordance with the National Environmental Policy Act of 1969.

The Flood Control Act (IC 14-28-1) requires the prior formal approval of the Department of Natural Resources for any proposal to construct, excavate, or fill in or on the floodway of a stream or other flowing waterbody which has a drainage area greater than one square mile. Please submit more detailed plans to the Division of Water's Technical Services Section if it appears that the project site occurs in a floodway.

The Natural Heritage Program's data have been checked. One state listed plant species was documented in about one foot of water on the southwest side of Cedar Lake in 1930. It is the state endangered Horned pondweed (*Zannichellia palustris*).

Our agency appreciates this opportunity to be of service and apologizes for not being able to respond sooner in this matter. Please do not hesitate to contact Christie Kiefer, Environmental Coordinator at (317) 232-4160 or at 1-877-928-3755 if we can be of further assistance.

Sincerely,

Michael W. Neyer, PE
Director
Division of Water

Note: Please include the above DNR # on any future correspondence regarding this project.

IN REPLY REFER TO:

United States Department of the Interior

FISH AND WILDLIFE SERVICE

BLOOMINGTON FIELD OFFICE (ES)
620 South Walker Street
Bloomington, Indiana 47403-2121
(812) 334-4261 FAX 334-4273

July 24, 2003

Mr. Douglas L. Mulvey
EnviroForensics
33 North LaSalle
Suite 2119
Chicago, Illinois 60602

Project: Cedar Lake Engineering Feasibility Study
Work Type: Water quality improvement project
Location: Town of Cedar Lake, Lake County, Indiana

Dear Mr. Mulvey:

This responds to your letter dated June 26, 2003, requesting endangered species information for the aforementioned project.

These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et. seq.) and are consistent with the intent of the National Environmental Policy Act of 1969, the Endangered Species Act of 1973, and the U. S. Fish and Wildlife Service's Mitigation Policy.

ENDANGERED SPECIES

The proposed project is within the range of the Federally endangered Indiana bat (Myotis sodalis) and Karner blue butterfly (Lycaeides melissa samuelis) and the threatened bald eagle (Haliaeetus leucocephalus), Pitcher's thistle (Cirsium pitcheri) and Mead's milkweed (Asclepias meadii).

The Indiana bat utilizes wooded riparian areas and adjacent wooded uplands as its summer nursery habitat. Maternity colonies roost under loose bark of dead or dying trees and feed along stream corridors. Suitable potential habitat for this species may be available along Cedar Creek and its tributaries downstream from Cedar Lake, but the tributaries into the lake may be too small and/or developed to support Indiana bats. However, the FWS considers this species to be present within suitable habitats unless proven otherwise. Therefore, we would need to evaluate specific project proposals in order to determine whether or not surveys for this species would be necessary.

There is no habitat for the Karner blue butterfly in the Cedar Lake area. Bald eagles are occasional winter visitors to lakes and rivers in northern Indiana, including Cedar Lake, but there is no specific habitat available for this species in the Cedar Lake area. Pitcher's thistle is a dune species along the Lake Michigan shoreline and is not found at Cedar Lake. Mead's milkweed is present at a State-owned nature preserve about 3 miles northwest of Cedar Lake, but this site is not within the lake watershed.

The large wetland complex at the south end of Cedar Lake is known to provide habitat for a number of Indiana-listed endangered, threatened, rare, or special concern species of flora and fauna. Among these are the special concern northern leopard frog and nesting Indiana endangered sedge and marsh wrens and special concern sandhill crane. This wetland complex, a large portion of which has been purchased for protection by a combination of Federal, State, and local funds, has been monitored for a number of by local volunteers. For information on the State-listed species found here, please contact the Indiana Division of Nature Preserves.

These endangered species comments constitute informal consultation only. They do not fulfill the requirements of Section 7 of the Endangered Species Act of 1973, as amended.

We appreciate the opportunity to comment at this early stage of project planning. Please keep us informed of project plans as they develop. If you have any questions, please call Elizabeth McCloskey at (219) 983-9753.

Sincerely yours,

Elizabeth S. McCloskey

for Scott E. Pruitt
Supervisor

cc: Christie Kiefer, Indiana Division of Water, Indianapolis, IN

Appendix B

Baetis ENVIRONMENTAL SERVICES, INC.

Technical Memorandum

SUBJECT	Screening and Identification of Projects			PROJECT NAME	Cedar Lake Enhancement Five Inlets EFS
INVESTIGATOR	D. B. Pott	DATE	3/08/03	PROJECT NUMBER	
CLIENT	EFI / CLEA			Page 1 of 8	

C:\Documents and Settings\David B. Pott.DPOTT\My Documents\Projects\CedarLake\TechMemo_030308.doc

Recommendations for the Engineering Feasibility Study (EFS)

Inlet	Recommendations for Detailed Investigation
North Point Marina	▪ Investigate installation of grass swales and/or roadside vegetative filters to stabilize eroding roadsides and ditches. ▪ Evaluate benefits related to enhanced ponding upstream of railroad embankment on west side of marina inlet. ▪ Confirming the sewer hookups for the trailers at the marina.
Condos Inlet	▪ Investigate installation of grass swales, roadside vegetative filters, and culvert outlet protection. ▪ Evaluate feasibility of a detention-based BMP in open channel.
Chamber of Commerce Inlet	▪ Investigate installation of grass swales and vegetative filters for roadsides and parking areas. ▪ Investigate potential enhancements to promote longer retention in existing wetland. ▪ Consider public education program for nuisance wildlife.
Old Bank Building	▪ Investigate check dams and/or stabilization of banks in the downcutting stream. ▪ Investigate installation of grass swales and vegetative filters for roadsides and parking areas. ▪ Evaluate installation of a detention-based BMP in the open channel east of Morse Street.
Golf Course Inlet	▪ Interview the golf course owners and managers and investigate their views on new vegetation management techniques to reduce goose use. ▪ Also investigate their willingness to install vegetative or structural bank protection.

We also recommend that the community take advantage of the DNR's public education programs related to nonpoint source runoff. An effective public education program will reduce solids, nutrients and other pollutants that run off lawns, roadsides, streets, parking areas, and driveways, and enter Cedar Lake.

Objective

The purpose of this Engineering Feasibility Study (EFS) of Five Small Inlets to Cedar Lake is to determine the feasibility of Best Management Practices and/or projects to enhance water quality in Cedar Lake, specifically remediating pollution from the Golf Course, Chamber of Commerce, Condos, and Old Bank Building inlets. Figure 1 is a map showing the locations of these five inlets.

The objective of this Technical Memorandum is to document the screening of potential BMPs for each inlet, and to propose one or two promising sites and/or options for water quality improvement projects at each inlet. These one or two sites/projects will be investigated in further detail as part of this EFS.

Background Information

A recently completed diagnostic study of five small inlets to Cedar Lake estimated phosphorus and nutrient loadings to the lake and ranked the inlets for pollution control projects and Best Management Practices (BMPs):

Inlet	Drainage Area	Mean Annual Loadings	
		Phosphorus	Sediment
North inlet	164 ac	138 kg	298 t
Old bank building	164 ac	1,770 kg	3,830 t
Golf course	69 ac	81 kg	176 t
North Point Marina	332 ac	1,809 kg	4,030 t
Condos	182 ac	2,369 kg	4,814 t

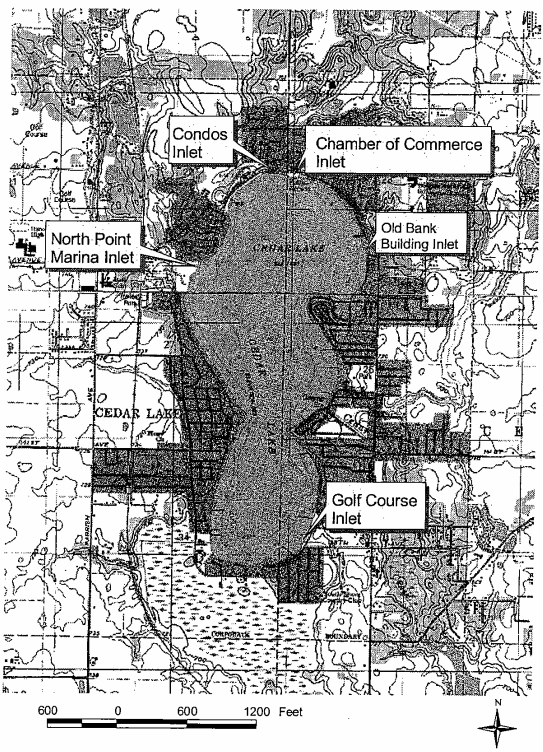


Figure 1. Locations of Five Small Inlets, Cedar Lake, Indiana
(Prepared by Environmental Forensic Investigations, Inc.)

Baetis
ENVIRONMENTAL SERVICES, INC.

Potential BMPs

Potential storm water Best Management Practices (BMP) are listed and described below. We have generally focused on BMPs for residential and commercial areas, because these land uses account for much of the drainage area.

The BMPs are generally grouped as filtration, infiltration, detention and post-development categories. In general, infiltration BMPs are not practical because soils in the area are generally poorly drained.

BMPs Identified for Cedar Lake, Indiana		
Type	**Description**	**Applicability to Cedar Lake**
Infiltration BMPs		
Infiltration Trench or Basin	Promote storm water infiltration into subsoils. They can be used to control runoff from parking lots, rooftops, or other impervious areas.	Suitable for relatively small drainage areas (less than 15 ac). Not suitable for locales with clay or silty soils, such as Cedar Lake.
Porous Pavement	Pavement that allows rain and snowmelt to pass through it, thereby reducing the runoff from a site. Storm water infiltrates through the underlying subsoil.	Requires deep permeable soils, restricted traffic. High rates of failure, especially in cold climates. Not recommended.
Filtration BMPs		
Vegetated Filter Strips / Buffers	A created or preserved area of vegetation designed to remove sediment and other pollutants through deposition, infiltration, absorption, and vegetative uptake.	Applicable to a variety of urban land uses where surface water runoff is discharged as overland sheet flow. Generally applied to drainage areas < 5 ac.
Grassed Swales	A broad, shallow channel with a dense stand of vegetation on side slopes and bottom. Designed to trap solids, promote infiltration, and reduce the flow velocity of runoff.	Also applicable to a variety of urban land uses. Can replace curbs, gutters and storm sewer systems.
Sand Filters / Filtration Basins	Sand filters handle runoff from relatively small drainage areas. Have good solids removal efficiencies, but generally low nutrient and metal removal capabilities. Require maintenance to prevent clogging.	Significant O&M requirements and limited capabilities to treat large drainage areas (>2 ac).
Bioretention	Utilizes soils and plants to remove pollutants from storm water.	Applicable, but treats runoff from small drainage areas. Can be costly.
Detention BMPs		
Dry Ponds	Providing both retention and treatment of storm water, but do not have permanent pools.	Water quality benefits generally limited to sedimentation, and are less than wet ponds or vegetated wetlands. Small sites or dense development may limit applicability.

BMPs Identified for Cedar Lake, Indiana		
Type	**Description**	**Applicability to Cedar Lake**
Wet Ponds	Runoff from rain event is detained and treated in the pond until it is displaced by runoff from the next storm.	Sedimentation and biological uptake processes remove pollutants. Small sites or highly developed areas may limit applicability.
Wetlands	Various types of free-water-surface wetlands can treat storm water.	Natural wetlands are generally not permitted for storm water treatment in IN. Constructed wetlands acceptable.
Oil/Grit Separators / Catch Basins	Removes coarse solids, including litter, and oil. Requires significant maintenance.	Generally requires curb and guttering, but could be retrofitted w/o these. Significant O&M costs to the Town. Widely used in the U.S.
Non-Structural BMPs		
Urban Housekeeping	Includes porous pavement, limiting exposure of materials and equipment to rainfall, spill cleanup, limiting direct runoff of rooftops to storm drains, other urban tools. Education may be a significant component.	Applicable, but may increase O&M costs to Town.
Turf Maintenance	Education is a significant component.	Applicable.
Street Sweeping	Removes solids accumulation from streets and parking areas.	Applicable, but will increase O&M costs to Town.
Road Maintenance	Includes resurfacing, regarding, and rehabilitation of curbing. Needed in many areas of Cedar Lake.	Applicable, but many roads are currently gravel and are a source of sediment to lake.

North Point Marina

Three small drainage ditches enter the dredged channel at North Point Marina on the northwest side of Cedar Lake. The ditches drain 332 ac, largely residential areas with gravel roads. The roads and roadsides are showing some sign of surface erosion. Seasonal trailers adjacent to the channel appear to be sewered.

This subwatershed ranked second as a source of nutrients and sediment among the five inlets being studied.

In 2000, two water quality samples were collected by Harza during wet weather. The 360 coliform bacteria cells/100 mL is somewhat high, and exceeds the state standard for recreational use. Suspended solids concentrations were high on both sampling occasions.

Water Quality Data for North Point Marina		
Parameter	**20/3/2000**	**12/5/2000**
E. coli (per 100 mL)	360	<3
BOD_5 (mg/L)	<4	<4
Ammonia N (mg/L)	<0.5	<0.5
Nitrate N(mg/L)	2.7	<1
o-Phoshorus (mg/L)	0.31	0.07
Total Phosphorus (mg/L)	0.14	0.13
Suspended Solids (mg/L)	18	99
Conductivity (mS/cm)	-	1.12
Turbidity (NTU)	-	7

The source of the E. coli is likely wildlife and/or pet waste, although I recommend further EFS efforts include confirming the sewer hookups for the trailers at the marina.

The suspended solids loads are derived from erosion of disturbed or unmaintained roads, roadsides and ditches. We recommend the EFS investigate installation of grass swales and/or roadside vegetative filters to stabilize these sources. The residential and commercial/industrial areas draining from the southwest are temporarily ponded in a lawn and shrub area prior to passing through a culvert under an abandoned railroad embankment; this detention area may provide an opportunity for longer detention times and greater water quality treatment.

Condos Inlet

There is a small inlet on north shore of Cedar Lake adjacent to a condominium building. The 182-ac drainage is largely residential. Gravel roads, roadsides, and driveways are a potential source of sediment. The drainage discharges through a 30-inch sewer to a narrow 200-ft open channel leading to Cedar Lake (see photos). A small sand delta appears to be accumulating on lake shore.

In 2000, two water quality samples were collected by Harza during wet weather. All values were relatively low, except for water conductivity on May 12, 2000. Interestingly, these values contrast to the model results that indicated this drainage to be the highest source of nutrients and sediment to Cedar Lake among the five inlets being studied.

Water Quality Data for Condos Inlet		
Parameter	**20/3/2000**	**12/5/2000**
E. coli (per 100 mL)	270	93
BOD_5 (mg/L)	<4	<4
Ammonia N (mg/L)	<0.5	<0.5
Nitrate N(mg/L)	1.5	1.1
o-Phoshorus (mg/L)	0.13	0.06
Total Phosphorus (mg/L)	0.09	0.1
Suspended Solids (mg/L)	13	8
Conductivity (mS/cm)	-	3.19
Turbidity (NTU)	-	7

The suspended solids loads are derived from erosion of disturbed or unmaintained roads and partking areas, eroding inlets and outlets of culverts, driveways, roadsides and ditches. We recommend the EFS investigate installation of grass swales, roadside vegetative filters, and culvert outlet protection to stabilize these sources. The

open channel leading to the lake also offers a potential site for a oil/grit separator or detention-based BMP, and the EFS should investigate the potential for CDS (or equivalent) devices, bioretention, wetland or wet pond treatment there.

Chamber of Commerce Inlet

This inlet drains through an 11-ac wetland on the north side of the road. The outlet has clean gravel on the bed of this channel, perhaps indicating that the wetland traps most sediment in that portion of the drainage basin before it enters the lake. Echelberger *et al.* (1984) noted that water flows in both directions at this inlet, depending upon water levels and rainfall amounts.

In 2000, three water quality samples were collected by Harza during wet weather. Phosphorus, coliform bacteria and suspended solids were relatively high on some or all sampling occasions.

Water Quality Data for Chamber of Commerce Inlet

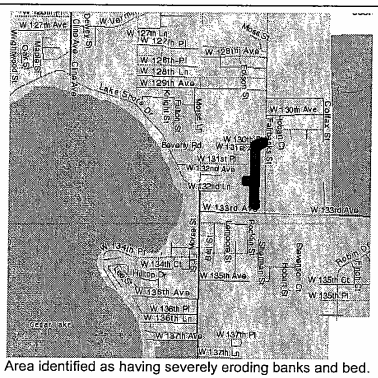
Parameter	28/2/2000	20/3/2000	12/5/2000
E. coli (per 100 mL)	3	70	93
BOD_5 (mg/L)	<4	<4	<4
Ammonia N (mg/L)	<0.5	<0.5	2
Nitrate N(mg/L)	1.8	<1	<1
o-Phoshorus (mg/L)	0.12	<0.06	0.07
Total Phosphorus (mg/L)	0.19	0.11	0.38
Suspended Solids (mg/L)	<5	12	78
Conductivity (mS/cm)	-	-	1.04
Turbidity (NTU)	-	-	7

The source of the E. coli (and likely phosphorus) is probably wildlife and/or pet waste. Some of these pollutants may come from waterfowl use of the wetland north of the Chamber or feeding in adjacent lawns. Public education regarding the disposal of pet waste and feeding of nuisance birds may mitigate these pathogen levels.

The phosphorus and suspended solids loads are derived from erosion of disturbed or unmaintained roads, driveways, roadsides and ditches. We recommend the EFS investigate installation of grass swales and vegetative filters for roadsides and parking areas. The existing inlet channel is not vegetated; the EFS should also evaluate the feasibility of adding vegetation to this inlet for water quality treatment, slowing flows, and aesthetics. While the existing wetland aids in water quality protection, modification of natural wetlands for storm water management is not viewed positively by regulatory agencies and would likely face difficulties obtaining permits from IDEM and DNR.

Old Bank Building

Just south of the now-closed bank building, there are two 2-ft diameter storm sewers draining a 164-ac area on the northwest side of the lake's watershed. On the east side of Morse Street, it becomes an open channel (note photos in attachment). The upstream tributary area is forested, residential and commercial, with some tilled agricultural land in upper reach of this subwatershed. Based upon estimated sediment and nutrient loads, Harza ranked the drainage third for BMP installation.



Area identified as having severely eroding banks and bed.

During field reconnaissance, we observed some upstream channels, by 133rd Ave and Fairbanks St., showing significant downcutting, and bank and bed erosion. The photographs in the attachment show some of this erosion.

In 2000, three water quality samples were collected by Harza during wet weather. Nutrients, coliform bacteria and suspended solids were relatively high on some or all sampling occasions.

As at the condos inlet, the source of the E. coli is probably wildlife and/or pet waste. Public education regarding the disposal of pet waste and feeding of nuisance birds may mitigate these pathogen levels as well as solids and nutrient loadings from this subwatershed.

Water Quality Data for Old Bank Building Inlet			
Parameter	**28/2/2000**	**20/3/2000**	**12/5/2000**
E. coli (per 100 mL)	150	270	93
BOD5 (mg/L)	<4	<4	6
Ammonia N (mg/L)	<0.5	<0.5	<0.5
Nitrate N(mg/L)	1.7	1.5	<1
o-Phoshorus (mg/L)	0.04	0.012	0.05
Total Phosphorus (mg/L)	0.04	0.18	0.18
Suspended Solids (mg/L)	58	11	140
Conductivity (mS/cm)	-	-	1.15
Turbidity (NTU)	-	-	10

The suspended solids loads are derived from erosion of stream bed and banks, and runoff from disturbed or unmaintained roads, driveways and parking areas. We recommend the EFS investigate check dams for the downcutting stream, and the installation of grass swales and vegetative filters for roadsides and parking areas. There is also sufficient land available along the open channel east of Morse Street for a detention-based BMP. We recommend the EFS investigate wet pond or wetland treatment here.

Golf Course

On the southwest side of the lake, 69 acres of the golf course drains into the lake. There is a weir at the golf course inlet that maintains a relatively constant water level. Echelberger *et al.* (1984) noted that water flows in both directions at this inlet, depending upon water levels and rainfall amounts. Field photos illustrate the poor bank protection provided by turf grasses on these banks.

In 2000, three water quality samples were collected by Harza during wet weather at the golf course weir. Phosphorus, coliform bacteria, turbidity, and suspended solids were relatively high on some or all sampling occasions.

Water Quality Data for Golf Course Inlet			
Parameter	**28/2/2000**	**20/3/2000**	**12/5/2000**
E. coli (per 100 mL)	<3	130	460
BOD_5 (mg/L)	<4	6	20
Ammonia N (mg/L)	<0.5	<0.5	<0.5
Nitrate N(mg/L)	1.0	<1	<1
o-Phoshorus (mg/L)	0.04	0.22	0.02
Total Phosphorus (mg/L)	0.05	0.22	0.18
Suspended Solids (mg/L)	46	68	40
Conductivity (mS/cm)	-	-	0.415
Turbidity (NTU)	-	-	40

The source of the E. coli (and likely BOD and phosphorus) is probably wildlife, particularly Canada geese that use the golf course for feeding or loafing areas. Other waterfowl may also contribute to loads. Vegetation management would reduce the populations of geese on the golf course and partially reduce these pollutant loads.

The suspended solids loads are derived from sloughing and erosion of poorly protected banks along the channel. We recommend the EFS interview the golf course owners and managers and investigate their willingness to install vegetative or structural bank protection, and other techniques to reduce pollutant loads to the lake.

References

Echelberger, Jr., W. F. *et al.* Cedar Lake Restoration Feasibility Study Final Report. 1984. Indiana University School of Public and Environmental Affairs.

Harza Engineering Company. 2000. Cedar Lake Diagnostic Feasibility Study. Prepared for Cedar Lake Enhancement Association, Inc.

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PHOTO LOG

SUBJECT	Inlet Reconnaissance	PROJECT NAME	Cedar Lake Enhancement Five Inlets EFS
PHOTOGRAPHER	dbp	DATE 1/24/03	PROJECT NUMBER

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North Point Marina. Three small drainage ditches enter this dredged channel. Ditches drain residential area, gravel roads showing some sign of surface erosion. Seasonal trailers appear to be sewered.

A residential area to the west of an abandoned railroad drains to North Point Marina.

There is ponding in a lawn upstream of a culvert going under the RR embankment. This site may offer an opportunity for a detention-based BMP. Some streambank erosion along the channel downstream of culvert.

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PHOTO LOG

SUBJECT	Inlet Reconnaissance	PROJECT NAME	Cedar Lake Enhancement Five Inlets EFS
PHOTOGRAPHER	dbp	DATE 1/24/03	PROJECT NUMBER

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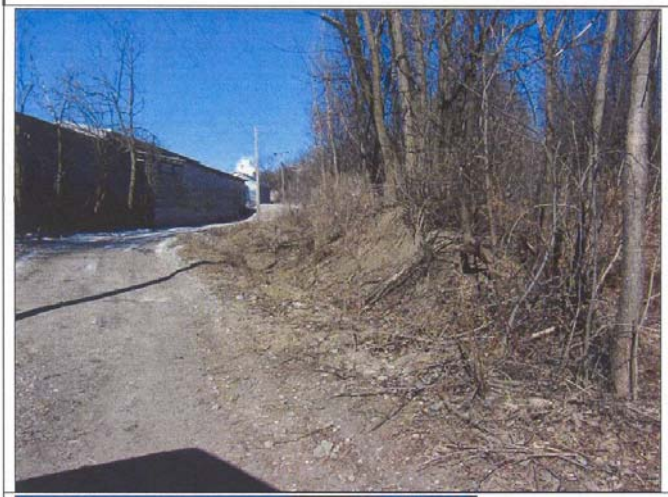
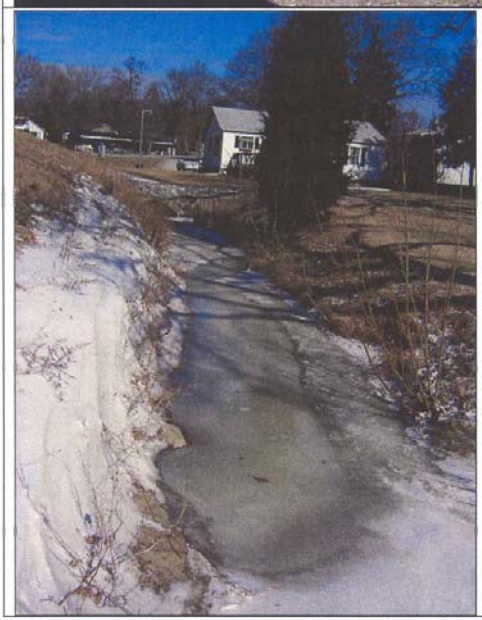


At the rear of this industrial facility, roadside clearing has exposed soils. This site drains directly to North Point Marina.



Condos inlet on north shore of Cedar Lake. 182-ac drainage is largely residential. Gravel roads, roadsides, and driveways are a potential source of sediment. Small sand delta accumulating on lake side.

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PHOTO LOG

SUBJECT	Inlet Reconnaissance	PROJECT NAME	Cedar Lake Enhancement Five Inlets EFS
PHOTOGRAPHER	dbp	DATE 1/24/03	PROJECT NUMBER

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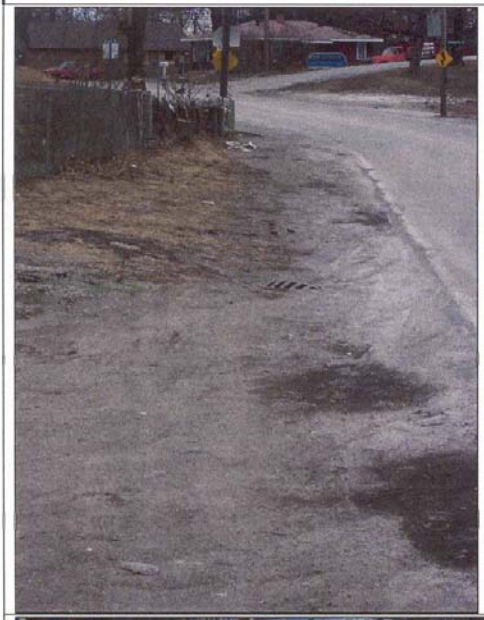

Many roadsides in Cedar Lake are sources of sediment, exemplified by this photo of a roadside storm drain that leads to the condos inlet.

North inlet (adjacent to the Chamber of Commerce). Note clean gravel on the bed of this channel. Wetland north of road offers a potential location for project.

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PHOTO LOG

SUBJECT	Inlet Reconnaissance	PROJECT NAME	Cedar Lake Enhancement Five Inlets EFS
PHOTOGRAPHER	dbp	DATE 1/24/03	PROJECT NUMBER

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This wetland across from the Chamber of Commerce, and the channel leading to the lake both offer potential project sites.

Channel leading to lake near the old bank building. Note potential site for a detention or filtration-based BMP project across Lakeshore Drive.

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PHOTO LOG

SUBJECT	Inlet Reconnaissance	PROJECT NAME	Cedar Lake Enhancement Five Inlets EFS
PHOTOGRAPHER	dbp	DATE 1/24/03	PROJECT NUMBER

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Old bank building channel. Drainage area is forested and residential, with some tilled agricultural land in upper watershed.

Upstream channels by 133rd Ave and Fairbanks St. show signs of downcutting/bank erosion.

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PHOTO LOG

SUBJECT	Inlet Reconnaissance	PROJECT NAME	Cedar Lake Enhancement Five Inlets EFS
PHOTOGRAPHER	dbp	DATE 1/24/03	PROJECT NUMBER

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Golf course inlet. Note lack of vegetative or stone protection on banks.

Weir structure maintains water level.

Appendix C

EnviroForensics

Memo

To: Jennifer Bratthauar, IDNR

From: Doug Mulvey

CC:

Date: 3/29/2004

Re: Potential Cedar Lake Wetland Structures

Jennifer-

I met onsite on February 25, 2004 at Cedar Lake with Marty Maupin from the Indiana Department of Environmental Management and Keith Poole from the Indiana Department of Natural Resources. I gave a quick tour of the proposed wetland/sedimentation basin sites at North Point Marina Inlet and the Old Bank Building Inlet that we had proposed in our Engineering Feasibility Study. Keith had seen our report and had some idea of what we had proposed for a number of areas in the watershed. Each gentleman had no problems with the conceptual approach that we had described in our Feasibility Study. Each agreed that it could be permitted. Keith mentioned that he would call you to discuss our meeting.

Appendix D

Figure 1: Condos Inlet

Figure 2: Turbid Water from Condos Inlet into Cedar Lake

Figure 3: Typical Manhole Inlet

Figure 4: Another Typical Manhole Inlet

Figure 5: Turbid Water and Flooding in Condos Inlet Watershed

Figure 6: Proposed Wetland Development Area in Old Bank Building Watershed

Figure 7: Golf Course Inlet

Figure 8: Failing Streambanks at Golf Course Inlet, North of 145th Avenue

Figure 9: Failing Streambanks at Golf Course Inlet, South of 145th Avenue

Figure 10: Existing Streambank Protection in Golf Course Inlet, South of 145th Avenue

Figure 11: Existing culvert under Monon Line near proposed North Point Marina wetland outlet.

Figure 12: Existing area of proposed North Point Maria wetland.

Appendix E

Area in acres

Land Use	Sleepy Hollow Ditch	North Point Marina	Condos	Chamber of Commerce	Old Bank Building	Golf Course	Cedar Lake Marsh	Other areas	Total
Urban	203.01	43.16	18.34	52.31	18.47	9.88	78.15	237.7	661.0
Golf Course						37.72			37.7
Agriculture	887.24	81.33	47.84	7.42	82.18		1504.63	74.8	2685.4
Forested	73.4	160.54	116.23	88.34	63.11	21.22	143.9	156.18	822.9
Wetland	4.51	19.22		11.80			364.89	34.41	434.8
Water		28.10		3.81				781	812.9
Total	1168.16	332.35	182.41	163.68	163.76	68.82	2091.57	1284.09	5454.8

Area in hectares

Land Use	Sleepy Hollow Ditch	North Point Marina	Condos	Chamber of Commerce	Old Bank Building	Golf Course	Cedar Lake Marsh	Other areas	Total
Urban	82.16	17.47	7.42	21.17	7.48	4.00	31.63	96.20	267.5
Golf Course	0	0	0	0	0	15.26	0	0	15.3
Agriculture	359.07	32.91	19.36	3.00	33.26	0	608.92	30.27	1086.8
Forested	29.70	64.97	47.04	35.75	25.54	8.59	58.24	63.21	333.0
Wetland	1.83	7.78	0	4.77	0	0	147.67	13.93	176.0
Water	0	11.37	0	1.54	0	0	0	316	329.0
Total	472.75	134.50	73.82	66.24	66.27	27.85	846.46	519.67	2207.6

Variable	Value	Unit	Source
Areal water loading	1.84	m/y	Echelberger et al 1984
Lake surface area	316	ha	
Pop served by Septics	248	cap	Echelberger et al 1984
Internal loads	see below		Echelberger et al 1984, Harza 1999

Phosphorus Export Coefficients	High	Most Likely	Low	Units
Urban	2	1.5	0.5	kg/ha/yr
Golf Course	0.6	0.5	0.2	kg/ha/yr
Agriculture	4	3	1	kg/ha/yr
Forested	0.4	0.15	0.02	kg/ha/yr
Wetland	0.2	0.1	-0.1	kg/ha/yr
Atmosphere	0.4	0.4	0.1	kg/ha/yr
Internal	21.9	18	16.5	kg/ha/yr
On-Site Systems	1.8	0.65	0.3	kg/cap/yr

Source Areas	Source	High	Most Likely	Low	Units
Sleepy Hollow Ditch	Urban	164	123	41	kg/yr
2	Golf Course	0	0	0	kg/yr
	Agriculture	1293	808	269	kg/yr
	Forested	12	4	0.6	kg/yr
	Wetland	0.4	0.2	-0.2	kg/yr
	Total	1469	936	311	kg/yr
North Point Marina	Urban	35	26	9	kg/yr
3	Golf Course	0	0	0	kg/yr
	Agriculture	132	99	33	kg/yr
	Forested	26	10	1.3	kg/yr
	Wetland	2	1	-0.8	kg/yr
	Water	5	5	1	kg/yr
	Total	199	140	43	kg/yr
Condos	Urban	15	11	4	kg/yr
4	Golf Course	0	0	0	kg/yr
	Agriculture	77	58	19	kg/yr
	Forested	19	7	0.9	kg/yr
	Wetland	0	0	0	kg/yr
	Total	111	76	24	kg/yr
Chamber of Commerce	Urban	42	32	11	kg/yr
5	Golf Course	0	0	0	kg/yr
	Agriculture	12	9.0	3	kg/yr
	Forested	14	5	0.7	kg/yr
	Wetland	1	0.5	0	kg/yr
	Water	0.6	0.6	0.2	kg/yr
	Total	70	47	14	kg/yr
Old Bank Building	Urban	15	11	4	kg/yr
6	Agriculture	133	100	33	kg/yr
	Forested	10	4	0.5	kg/yr
	Total	158	115	38	kg/yr

Golf Course	Urban	8	6	2 kg/yr
7	Golf Course	9	8	3 kg/yr
	Agriculture	0	0	0 kg/yr
	Forested	3	1.3	0.2 kg/yr
	Wetland	0	0	0 kg/yr
	Sum	21	15	5 kg/yr
% reduction due to closed gate		25%	50%	75%
	Total	15	7.5	1.3
Cedar Lake Marsh	Urban	63	47	16 kg/yr
8	Golf Course	0	0	0 kg/yr
	Agriculture	2436	1827	609 kg/yr
	Forested	23	9	1.2 kg/yr
	Wetland	30	15	-15 kg/yr
	Total	2552	1898	611 kg/yr
Other areas	Urban	192	144	48 kg/yr
9	Golf Course	0	0	0 kg/yr
	Agriculture	121	91	30 kg/yr
	Forested	25	9	1.3 kg/yr
	Wetland	3	1	-1 kg/yr
	Water	126	126	32 kg/yr
	Internal	6922	5689	5215 kg/yr
	On-Site Systems	112	40	19 kg/yr
	Total	7502	6102	5344 kg/yr
Cedar Lake Loads	Urban	533	398	132 kg/yr
10	Golf Course	7	4	1 kg/yr
	Agriculture	4204	2991	997 kg/yr
	Forested	132	49	7 kg/yr
	Wetland	35	18	-18 kg/yr
	Atmosphere	132	132	33 kg/yr
	Internal	6922	5689	5215 kg/yr
	On-Site Systems	112	40	19 kg/yr
	Total	12076	9321	6386 kg/yr
	Check	12076	9321	6386

Lake Response	**High**	**Most Likely**	**Low**	**Units**
Areal P Load	3.8	2.9	2.0	g/m2/yr
P Concentration	0.28	0.21	0.15	mg/L

Prediction Uncertainty	log P		-0.670	
	positive model error		0.073	
	negative model error		-0.055	
	pos loading error		0.032	
	neg loading error		0.034	
	total pos uncertainty		0.080	
	total neg uncertainty		0.064	
	55% confidence limits	0.293		0.150
	90% confidence limits	0.373		0.085

Analysis of Project Effects

1 Old Bank Building Wetland		units
Assume 40% reduction in P loadings from subwatershed		
Pre-Project P Load	115	kg/yr
Post-Project P Load	69	kg/yr
Post-Project Overall P Load	9275	kg/yr
% Overall Load Reduction	0.5%	
Pre-Project Lake P	0.21	mg/L
Post-Project Lake P	0.21	mg/L
% Overall Conc Reduction	0.5%	

2 North Point Marina Wetland		
Portion of Watershed Affected	50%	
Assume 25% reduction in P loadings from subwatershed		
Pre-Project P Load	140	kg/yr
Post-Project P Load	105	kg/yr
Post-Project Overall P Load	9286	kg/yr
% Overall Load Reduction	0.4%	
Pre-Project Lake P	0.21	mg/L
Post-Project Lake P	0.21	mg/L
% Overall Conc Reduction	0.4%	

Appendix F

Appendix F
Funding and Technical Resources

Funding Agency	Program Name or Authorization	Requirements
USDA	Conservation Reserve Program (CRP)	CRP is a voluntary program that offers long-term rental payments and cost-share assistance to establish long-term resource conserving cover on environmentally sensitive cropland or, in some cases, marginal pasture land.
USDA-NRCS	Wildlife Habitat Incentives Program (WHIP)	The WHIP is a voluntary program to develop and improve wildlife habitat on private lands. It provides both technical assistance and cost sharing to help establish and improve fish and wildlife habitat.
Department of Interior - USFWS	Partners for Wildlife Habitat Restoration Program (PWHRP)	The PWHRP provides technical and financial assistance to private landowners through voluntary cooperative agreements to restore degraded wetlands, native grasslands, riparian areas, and other habitats.
Department of Interior - USFWS	Wildlife Conservation and Appreciation Program (WCAP)	The WCAP provides grants to fund projects that bring together USFWS, State agencies, and private organizations and individuals. Projects include identification of significant problems that can adversely affect fish and wildlife and their habitats; actions to conserve species and their habitats; actions that will provide opportunities for the public to use and enjoy fish and wildlife through nonconsumptive activities; monitoring of species; and identification of significant habitats.
USEPA	Sustainable Development Challenge Grants	Grants are intended to initiate community-based projects that promote environmentally and economically sustainable development. This program challenges communities to invest in a sustainable future that will link environmental protection, economic prosperity, and community well-being.
USEPA	Environmental Justice Grants to Small Community Groups	This grant program provides financial assistance to community-based organizations and Tribal governments to support projects to design, demonstrate or disseminate practices, methods, or techniques related to environmental justice.
USDA - USFS	Cooperative Forestry Assistance Program (CFAP)	CFAP helps State Foresters or equivalent agencies with forest stewardship programs on private, State, local, and other non-Federal forest and rural lands, plus rural communities and urban areas. This program helps to achieve ecosystem health and sustainability by improving wildlife habitat, conserving forest land, reforestation, and improving soil and water quality.
		The FIP is intended to ensure the Nation's ability to meet future demand for

Appendix F
Funding and Technical Resources

USDA - NRCS	Forestry Incentives Program (FIP)	sawtimber, pulpwood, and quality hardwoods. FIP provides cost share monies to help with the costs of tree planting, timber stand improvements, and related practices.
USDA - NRCS	Small Watershed Program	This program works through local government sponsors and helps participants solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres.
USEPA	Nonpoint Source Implementation Grants (319 Program)	Clean Water Act's Section 319 provides formula grants to the States to implement nonpoint source projects and programs. 25% cost share requirements.
USEPA	Pollution Prevention Grants Program	This program provides grants to States to implement pollution prevention projects.
USEPA	Water Quality Cooperative Agreements (104(b)(3))	Grants are provided to support creation of unique and new approaches to meeting stormwater, combined sewer outflows, sludge, and pretreatment requirements as well as enhancing State capabilities. Cost share is encourage.
USDA - NRCS	Wetlands Reserve Program (WRP)	The WRP is a voluntary program to restore and protect wetlands on private property. WRP provides landowners with financial incentives to enhance wetlands in exchange for retiring marginal agricultural land.
Department of Interior - USFWS	North American Wetlands Conservation Act Grant Program (NAWCA)	The NAWCA grant program promotes long-term conservation of North American wetland ecosystems, and the waterfowl and other migratory birds, fish and wildlife that depends upon such habitat. Principal conservation actions supported by NAWCA are acquisition, enhancement, and restoration of wetlands and wetlands-associated habitat.
USDA	Agricultural Conservation Program	The purpose of this program is to control erosion and sedimentation, encourage voluntary compliance with federal and state requirements to solve point and nonpoint source pollution, and improve water quality, among other objectives.
USDA - Forest Service	Stewardship Incentive Program	This program encourages private landowners to manage their forest land in

Appendix F
Funding and Technical Resources

		ways that improve water quality, including tree planting and the implementation of best management practices for stream crossings and streamside management.
Department of Interior - Bureau of Reclamation	Construction Program	This program provides funding and assistance for the implementation of structural and operational measures to improve water management.
Department of Interior - USFWS	Refuges and Wildlife - North American Waterfowl Management Plan	To support a strategy for cooperative public/private wetland habitat conservation that will reverse decline in waterfowl and other wetland wildlife species in the United States, Canada, and Mexico. Public and private entities that agree to enter into partnership to acquire, restore, and enhance wetlands are eligible.
USEPA	State Revolving Funds Capitalization Grants	This program provides long-term source financing to states for the construction of wastewater treatment facilities and the implementation of other high priority water quality management activities.
USEPA	Water Pollution Control Program Grants (Section 106)	This program assists states and interstate agencies in establishing adequate measures for prevention and control of surface water and groundwater pollution.
USACE	Section 206 "Aquatic Ecosystem Restoration"	Section 206 of the 1996 Water Resources Development Act provides authority for the Secretary to carry out an aquatic ecosystem restoration and protection project. A project is adopted for construction only after a detailed investigation determines that the project will improve the quality of the environment and is in the best interest of the public, and clearly shows the engineering feasibility and economic justification of the improvement.
USDA - Rural Utilities Service	Watershed Protection and Flood Prevention Loans	This program provides loan funds to help local sponsors provide the local share of the cost of watershed works of improvement for flood prevention, irrigation, drainage, water quality management, sedimentation control, fish and wildlife development, public water based recreation, and water storage and related costs.
USEPA	Clean Lakes Program (Section 314)	The Clean Lakes Program (Section 314 of CWA) provides assistance to States to assess water quality of publicly owned lakes, to diagnose the causes of degradation in lakes, to develop and implement lake restoration and protection plans, and for post restoration monitoring. Current federal policy has 314 funding included in the 319 program grants.

Appendix F
Funding and Technical Resources

USEPA	Water Quality Management Planning (205(J))	Section 604(b) funds are awarded under Section 205(j) to State water quality management agencies to carry out water quality management planning.
USEPA	Wetlands Protection Development Grants	These grants are intended to encourage wetlands protection program development or to enhance/augment existing effective programs.
Department of Interior - USFWS	Wildlife Conservation and Appreciation	This program is intended to establish a partnership among the USFWS, designated State Agencies, and private organizations and individuals to carry out wildlife conservation. Eligible projects include: identifications of the significant problems that may adversely affect fish and wildlife species and their significant habitats; actions to conserve fish and wildlife species and their habitats; and actions of which the principal purpose is to provide opportunities for the public to use and enjoy fish and wildlife through nonconsumptive activities.
IDNR	T-by-2000 / Lake and River Enhancement (LARE) Program	Intended to ensure the continued viability of Indiana's public access lakes and streams. Program goals are to control inflows of sediments and associated nutrients into lakes and streams. Qualifying projects include water quality monitoring, lake and watershed studies, feasibility studies, construction projects and watershed land treatment projects.
IDNR	T-by-2000 / Urban Conservation Program	State-funded soil conservation / water quality protection initiative aimed at significantly reducing soil erosion and resulting sedimentation. The main objective of the Urban Conservation Program is control of soil erosion and off-site sedimentation from non-farm lands.
USEPA	State Revolving Funds (SRF)	Under the SRF program, Indiana has created revolving loan funds to provide independent and permanent sources of low cost financing for a range of water quality infrastructure projects. Funds are available to fund a wide variety of water quality projects including all types of nonpoint source projects.
USACE	Planning Assistance to States Program	This program is intended for preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources. Typical studies conducted include water quality studies, flood plain management, environmental conservation, and many others.

Appendix G

PERMISSION TO ENTER PROPERTY

1. MARALYNN ECHTERLING ("undersigned"), owner, hereby gives permission to the Cedar Lake Enhancement Association and its agents and subcontractors to enter the undersigned's property ("the property") located at Drexel Avenue; 25' x 400' road right-of-way (vacant) behind True Value Store
2. This permission is contemplated to be used for the following activities which may be performed by the Cedar Lake Enhancement Association, its agents, representatives or subcontractors:
   A. Having access to the unnamed stream to construct a sediment trap structure.
   B. Having access to the unnamed stream to stabilize the streambank using minor grading (where needed), filter fabric, and rip-rap, glacial stone, or other approved hard armoring.
3. Upon completion of the work, the Cedar Lake Enhancement Association will restore the property as near as practicable to its condition immediately prior to the commencement of such activities.
4. The granting of this permission by the undersigned does not obligate the undersigned to pay for any improvements performed by the Cedar Lake Enhancement Association. The work will be performed by the Cedar Lake Enhancement Association at no cost to the undersigned.
5. The Cedar Lake Enhancement Association, its agents, representatives or subcontractors may enter the property during normal business hours and may also make special arrangements to enter the property at other times after agreement from the undersigned.
6. The Cedar Lake Enhancement Association acknowledges and accepts its responsibility for damages caused by the acts of its representatives while on the property.

Accepted by the Owner:

Maralynn Echterling
Maralynn Echterling, Clerk-Treasurer

April 7, 2004
Date

Per Cedar Lake Town Council's approval at the April 6, 2004 Public Meeting.

Accepted by the Cedar Lake Enhancement Association by the following authorized agent:

_____
Representative

_____
Date

PERMISSION TO ENTER PROPERTY

1. Ellen Phoetz ("undersigned"), owner, hereby gives permission to the Cedar Lake Enhancement Association and its agents and subcontractors to enter the undersigned's property ("the property") located at 9037 Lakeshore Dr. Cedar Lake, IN.

2. This permission is contemplated to be used for the following activities which may be performed by the Cedar Lake Enhancement Association, its agents, representatives or subcontractors:
   A. Having access to the unnamed stream to construct a sediment trap structure.
   B. Having access to the unnamed stream to stabilize the streambank using minor grading (where needed), filter fabric, and rip-rap, glacial stone, or other approved hard armoring.

3. Upon completion of the work, the Cedar Lake Enhancement Association will restore the property as near as practicable to its condition immediately prior to the commencement of such activities.

4. The granting of this permission by the undersigned does not obligate the undersigned to pay for any improvements performed by the Cedar Lake Enhancement Association. The work will be performed by the Cedar Lake Enhancement Association at no cost to the undersigned.

5. The Cedar Lake Enhancement Association, its agents, representatives or subcontractors may enter the property during normal business hours and may also make special arrangements to enter the property at other times after agreement from the undersigned.

6. The Cedar Lake Enhancement Association acknowledges and accepts its responsibility for damages caused by the acts of its representatives while on the property.

Accepted by the Owner:

Ellen Phoetz — Owner

4-8-04 — Date

Accepted by the Cedar Lake Enhancement Association by the following authorized agent:

_____ Representative

_____ Date

PERMISSION TO ENTER PROPERTY

1. Charles A. Binnie ("undersigned"), owner, hereby gives permission to the Cedar Lake Enhancement Association and its agents and subcontractors to enter the undersigned's property ("the property") located at 8121 Lakeshore DR. Cedar Lake IN

2. This permission is contemplated to be used for the following activities which may be performed by the Cedar Lake Enhancement Association, its agents, representatives or subcontractors:
   A. Having access to the unnamed stream to construct a sediment trap structure.
   B. Having access to the unnamed stream to stabilize the streambank using minor grading (where needed), filter fabric, and rip-rap, glacial stone, or other approved hard armoring.

3. Upon completion of the work, the Cedar Lake Enhancement Association will restore the property as near as practicable to its condition immediately prior to the commencement of such activities.

4. The granting of this permission by the undersigned does not obligate the undersigned to pay for any improvements performed by the Cedar Lake Enhancement Association. The work will be performed by the Cedar Lake Enhancement Association at no cost to the undersigned.

5. The Cedar Lake Enhancement Association, its agents, representatives or subcontractors may enter the property during normal business hours and may also make special arrangements to enter the property at other times after agreement from the undersigned.

6. The Cedar Lake Enhancement Association acknowledges and accepts its responsibility for damages caused by the acts of its representatives while on the property.

Accepted by the Owner:

Charles A. Binnie — 4-05-04

Owner — Date

Accepted by the Cedar Lake Enhancement Association by the following authorized agent:

_____ — _____

Representative — Date

PERMISSION TO ENTER PROPERTY

1. John R. Hays ("undersigned"), owner, hereby gives permission to the Cedar Lake Enhancement Association and its agents and subcontractors to enter the undersigned's property ("the property") located at _____.

2. This permission is contemplated to be used for the following activities which may be performed by the Cedar Lake Enhancement Association, its agents, representatives or subcontractors:
   A. Having access to the unnamed stream to stabilize the streambank using minor grading (where needed), filter fabric, and rip-rap, glacial stone, or other approved hard armoring.
3. Upon completion of the work, the Cedar Lake Enhancement Association will restore the property as near as practicable to its condition immediately prior to the commencement of such activities.
4. The granting of this permission by the undersigned does not obligate the undersigned to pay for any improvements performed by the Cedar Lake Enhancement Association. The work will be performed by the Cedar Lake Enhancement Association at no cost to the undersigned.
5. The Cedar Lake Enhancement Association, its agents, representatives or subcontractors may enter the property during normal business hours and may also make special arrangements to enter the property at other times after agreement from the undersigned.
6. The Cedar Lake Enhancement Association acknowledges and accepts its responsibility for damages caused by the acts of its representatives while on the property.

Accepted by the Owner:

John R Hays — Owner

4/9/04 — Date

Accepted by the Cedar Lake Enhancement Association by the following authorized agent:

_____ — Representative

_____ — Date

Appendix H

Environmental Assessment

We have opted to mimic the guidelines of the U.S. Environmental Protection Agency's Clean Lakes Program in order to assess the environmental effects of proposed projects in the five small subwatersheds. These guidelines involve a checklist approach to impact assessment and can be found in the Code of Federal Regulations, Title 40, Part 35, Subpart H. These guidelines involve 14 questions which may be satisfactorily answered with a mere "Yes" or "No", but should detail important benefits or adverse effects sufficiently to allow for mitigation planning during the design and implementation phases.

None of the proposed projects have significant adverse effects on the physical, biological or social environment. The small scale of the proposed projects limit their adverse effects on environmental resources.

Issue	North Point Marina	Condos	Chamber of Commerce	Old Bank Building	Country Club
Will the proposed project displace any people?	No	No	No	No	No
Will the proposed project deface existing residences or residential areas? What mitigative actions such as landscaping, screening, or buffer zones have been considered? Are they included?	No. Landscaping will be included in the design of the constructed wetland.	No	No	No. Landscaping will be included in the design of the constructed wetland near Morse Avenue.	No.
Will the proposed project be likely to lead to a change in established land use patterns, such as increased development pressure near the lake? To what extent and how will this change be controlled through land use planning, zoning, or through other methods?	Conversion of portion of a lawn area to naturalized area.	No	No	No	No
Will the proposed project adversely affect a significant amount of prime agricultural land or agricultural operations on such land?	No	No	No	No	No
Will the proposed project result in a significant adverse effect on parkland, other public land, or lands of recognized scenic value?	No	No	No	No	No. Riprap materials will be selected to match existing riprap.
Has the State Historical Society or State Historical Preservation Officer been contacted? Has he responded, and if so, what was the nature of that response? Will the proposed project result in a significant adversely effect on lands or structures of historic, architectural, archaeological or cultural value?	The SHPO has not been contacted but none of the proposed projects will affect historic structures or known cultural resources.	The SHPO has not been contacted but none of the proposed projects will affect historic structures or known cultural resources.	The SHPO has not been contacted but none of the proposed projects will affect historic structures or known cultural resources.	The SHPO has not been contacted but none of the proposed projects will affect historic structures or known cultural resources.	The SHPO has not been contacted but none of the proposed projects will affect historic structures or known cultural resources.
Will the proposed project lead to a significant long-range increase in energy demands?	No	No	No	No	No
Will the proposed project result in significant and long range adverse changes in ambient air quality or noise levels? Short term?	No	No	No	No	No
If the proposed project involves the use of in-lake chemical treatment, what long and short term adverse effects can be expected from that treatment? How will the project recipient mitigate these effects?	No in-lake treatments proposed.	No in-lake treatments proposed.	No in-lake treatments proposed.	No in-lake treatments proposed.	No in-lake treatments proposed.
Is the proposed project located in a floodplain? If so, will the project involve construction of structures in the floodplain? What steps will be taken to reduce the possible effects of flood	Project is outside of FEMA-mapped floodplain.	Projects are outside of FEMA-mapped floodplain.	Projects are outside of FEMA-mapped floodplain.	Project is outside of FEMA-mapped floodplain.	Project is outside of FEMA-mapped floodplain.

Issue	North Point Marina	Condos	Chamber of Commerce	Old Bank Building	Country Club
damage to the project?					
If the project involves physically modifying the lake shore or its bed or its watershed, by dredging, for example, what steps will be taken to minimize any immediate and long term adverse effects of such activities? When dredging is employed, where will the dredged material be deposited, what can be expected and what measures will the local sponsor employ to minimize any significant adverse impacts from its deposition?	Project is designed to reduce sediment and sediment-related pollutant loads to the lake.	Project is designed to reduce sediment and sediment-related pollutant loads to the lake.	Project is designed to reduce sediment and sediment-related pollutant loads to the lake.	Project is designed to reduce sediment and sediment-related pollutant loads to the lake.	Project is designed to reduce sediment and sediment-related pollutant loads to the lake.
Will the proposed project have a significant adverse effect on fish and wildlife, or on wetlands or any other wildife habitat, especially those of endangered species? How significant is this impact in relation to the local or regional critical habitat needs? Have actions to mitigate habitat destruction been incorporated into the project? Has the recipient properly consulted with appropriate State and Federal fish, game and wildlife agencies and with the U.S. Fish and Wildlife Service? What were their replies?	Negligible affects on fish, wildlife or protected resources.	Negligible affects on fish, wildlife or protected resources.	Negligible affects on fish, wildlife or protected resources.	Negligible affects on fish, wildlife or protected resources.	Negligible affects on fish, wildlife or protected resources.
Describe any feasible alternatives to the proposed project and why they were not proposed.	See Appendix on Identification and Screening of Alternatives	See Appendix on Identification and Screening of Alternatives	See Appendix on Identification and Screening of Alternatives	See Appendix on Identification and Screening of Alternatives	See Appendix on Identification and Screening of Alternatives
Describe other measures not discussed previously that are necessary to mitigate adverse environmental impacts resulting from the implementation of the proposed project.					

Appendix I

APPENDIX – FLORISTIC QUALITY ASSESSMENT

Vegetation communities at four of the five inlets being studied were inventoried and assessed using the Swink and Wilhelm Floristic Quality Assessment methodology. For a detailed discussion of this methodology see Swink *et al.* (1994). The Floristic Quality Assessment is a means of evaluating the vegetative quality of a site in relation to natural, or native, vegetative quality. Fundamental to this assessment is the assignment of a Coefficient of Conservatism value to each native species in the plant community. The C value varies from 0 ("weedy") to 10 ("conservative") and reflects a species relationship to an unaltered area with a natural plant community.

In general, these values may be interpreted as follows:

- Species with C values from 0 to 3 are likely to be found in some type of disturbed habitat. For example, a C of 0, is given to plants such as *Acer negundo*, box elder, that have demonstrated little fidelity to any remnant natural community and may be found almost anywhere.

- Species that have been assigned a C value of 4, 5, or 6 are as likely to be found in some type of disturbed natural area as they are to be found in an intact natural plant community. In general, these species are able to withstand a certain amount of disturbance and their presence is often indicative of an area that in the past may have been a rich assemblage of native plants.

- Species with C values from 7 to 10 are most likely to be found in some type of intact natural area and those species with a value of 9 or 10 are almost never found outside of an intact natural area.

- Introduced plants were not part of the pre-settlement flora, so no C value is applied to these.

The Mean C is an indicator of whether a site supports ecologically important plant communities of primarily native species and that are less disturbed by the actions of man. High values connote ecologically important communities and low values indicate that an area has little ecological significance.

Table A7-1 summarizes the vegetation community data for four sites surveyed: the ditch at the Condos Inlet, the ditch along 132nd Lane in the Old Bank Building, an eroding stream channel at 133rd and Fairbanks, and a wetland area in the North Point Marina drainage. All of the sites have been extensively disturbed and have little natural significance. In highly disturbed setting such as these, this analysis may actually overestimate vegetation quality because exotic species with no C value are present at each of the sites. Such plant species are not given C values because they were not part of the Chicago region's plant communities prior to European settlement. They exist on a site because of past disturbance (clearing and grading) and/or because they are aggressive invaders that push out the natural plant species.

Table A7-1
Floristic Quality Summary of the Cedar Lake Vegetation Survey Sites

	Condos Inlet	132nd Lane	133rd & Fairbanks	No Pt Marina
Total Plant Species	14*	14*	17	19
Number of Native Plant Species	6	6	9	12
Mean "C"	2.2	2.8	3.1	2.4
FQI	5.3	6.9	9.3	8.4

*Does not include unidentified lawn grasses.

The Floristic Quality Index (FQI) is an indicator of the significance of the plant community in relation to a native plant community. The higher the FQI the closer the plant community is to a native plant community. Areas with FQI values of less than 20 are extensively disturbed and have little natural significance. The very low FQI of the Cedar Lake sites indicates that they are extensively disturbed and bear little resemblance to native vegetation communities.

A7.1 Vegetation Surveys

Vegetation at four sites previously identified as potential BMP locations was identified on May 31, 2003. Those sites are shown in Figure A7-1. A general description of each site, together with species lists, is given below.

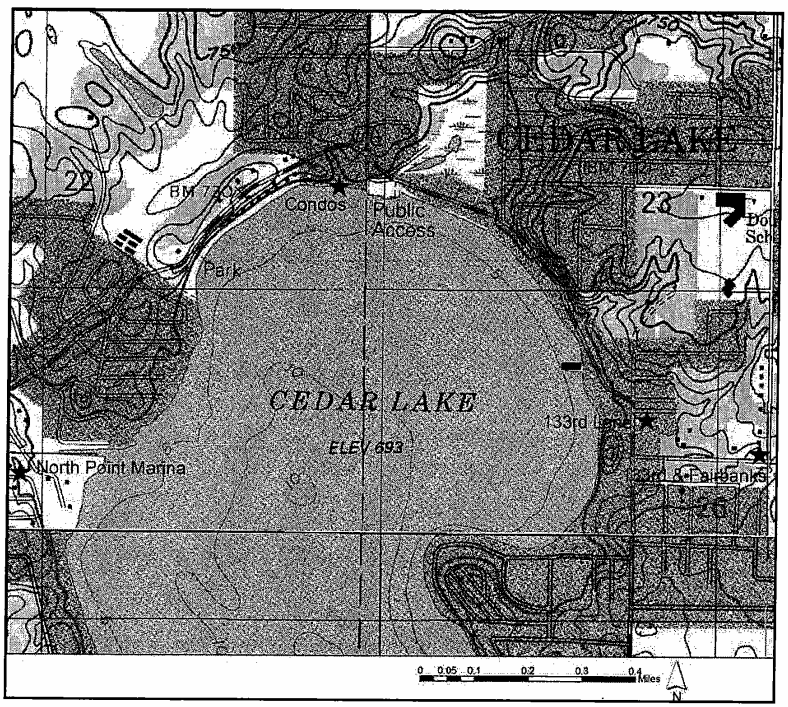

Figure A7 - 1. Vegetation Assessment Sites.

A.2 Condos Inlet

This narrow drainage separates a private residence from a condominium development. It is an open, disturbed area characterized by opportunistic herbaceous species. Lawn grasses from the adjacent properties extend to the drainage and are dominant plant species within the drainage. During the field visit, the vegetation along both banks had been recently mowed. Species present at the site included:

Common Name	Scientific Name
Bittersweet Nightshade	*Solanum dulcamara*
Black Medick	*Medicago lupulina*
Chestnut Oak	*Quercus prinus*
Common Cattail	*Typha latifolia*
Common Dandelion	*Taraxacum officinale*
Curly Dock	*Rumex crispus*
Field Horsetail*	*Equisitum arvense*
Great Ragweed	*Ambrosia trifida*
Ground Ivy, Creeping Charlie	*Glechoma hederacea*
Lawn Grasses*	
Morning Glory	*Ipomoea purpurea*
Queen Anne's Lace	*Daucus carota*
Riverbank Grape	*Vitis riparia*
Thistle	*Circium sp.*
Virginia Creeper	*Parthenocissus quinquefolia*

* Dominant vegetation

A.3 Ditch along 132nd Lane

This site is located behind the hardware store on Morse Avenue, and is parallel to 132nd Lane. It is an open, disturbed area characterized by opportunistic, weedy herbaceous and woody species. Lawn grass is the dominant vegetation at the site. During the field visit we observed that the vegetation along both banks had been recently mowed. Species present at the site included:

Common Name	Scientific Name
Common Dandelion	*Taraxacum officinale*
Common Plantain	*Plantago major*
Curly Dock	*Rumex crispus*
Ground Ivy, Creeping Charlie	*Glechoma hederacea*
Lawn Grasses*	
Multiflora Rose	*Rosa multiflora*
Poison Ivy	*Rhus radicans*
Riverbank Grape	*Vitis riparia*
Thistle	*Circium sp.*

Virginia Creeper	*Parthenocissus quinquefolia*
Willow	*Salix sp.*
Yellow Goatsbeard	*Tragopogon pratensis*

Along the drainage but near storm culvert upstream were the following species:

Common Name	Scientific Name
Green Ash	*Fraxinus pennsylvanica*
Cottonwood	*Populus deltoides*
Poison Ivy	*Rhus radicans*
Queen Anne's Lace	*Daucus carota*
Willow sp.*	*Salix sp.*

* Dominant vegetation

A.4 Eroding Channel at 133rd and Fairbanks

This is a wooded area dominated by honey locust.

Common Name	Scientific Name
Black Walnut	*Juglans nigra*
Box Elder	*Acer negundo*
Common Burdock	*Arctium minus*
Common Dandelion	*Taraxacum officinale*
Curly Dock	*Rumex crispus*
Day Lily	*Hemerocallis fulva*
Green Ash	*Fraxinus pennsylvanica*
Ground Ivy, Creeping Charlie	*Glechoma hederacea*
Honey Locust*	*Gleditsia triacanthos*
Jewelweed	*Impatiens capensis*
Morning Glory	*Ipomoea purpurea*
Multiflora Rose	*Rosa multiflora*
Poison Ivy	*Rhus radicans*
Raspberry*	*Rubus sp.*
Reed Canary Grass	*Phalaris arundinacea*
Rough Avens	*Geum laciniatum*
Solomen's Seal	*Polygonatum sp.*

* Dominant vegetation

A.5 North Point Marina Site

This is a wooded riparian area adjacent to a residential lawn. Storm water ponds there temporarily. Species present at the site included:

Common Name	Scientific Name
Bittersweet Nightshade	*Solanum dulcamara*
Box Elder	*Acer negundo*
Common Burdock	*Arctium minus*
Chestnut Oak	*Quercus prinus*
Clustered Snakeroot	*Sanicula gregaria*
Common Dandelion	*Taraxacum officinale*
Day Lily*	*Hemerocallis fulva*
False Soloman's Seal	*Smilacana racemosa*
Great Ragweed	*Ambrosia trifida*
Ground Ivy, Creeping Charlie*	*Glechoma hederacea*
Jewelweed*	*Impatiens capensis* Nettle sp.
Poison Ivy	*Rhus radicans*
Reed Canary Grass	*Phalaris arundinacea*
Silver Maple*	*Acer saccharinum*
Solomen's Seal	*Polygonatum sp.*
Tree-of-Heaven	*Ailanthus altissima*
Virginia Creeper	*Parthenocissus quinquefolia*
Willow	*Salix sp.*

* Dominant vegetation